MEMOIRS
OF THE
UNIVERSITY OF CALIFORNIA

Volume 2

# THE SILVA OF CALIFORNIA

BY

WILLIS LINN JEPSON

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# PREFACE.

Botanical knowledge of the Californian silva begins with the visits of the Malaspina and the Vancouver expeditions, the first scientific voyages, save the La Perouse expedition, to touch Californian shores. The botanists attached to the Malaspina and the Vancouver voyages made known to the European world the existence of *Sequoia sempervirens, Quercus lobata, Quercus agrifolia, Arbutus Menziesii* and several other trees. Following that period one hundred and twenty years have gone by, but on account of the peculiar topography and the extent of the State and the restricted or local range of many species of its silva botanical discovery has proceeded slowly. Even at this time the census of our trees may be incomplete, since it is only within the last year that *Cereus giganteus,* a well-known species of Arizona and Sonora, has been discovered within the limits of California.

Since the time of Vancouver botanical knowledge of the native trees has mainly found expression in formal and rather short diagnoses of the species, with a general indication of range, although there have been occasional and valuable studies on the embryology and histology of a few species. It is the object of this memoir to bring together in one volume an account of the timber trees of the State which shall as nearly as possible represent our present knowledge of the taxonomy and geographical distribution. To this the writer is adding the results of such studies as he has been enabled to make upon the dendrological characteristics of various species, their habits, architectural form, seed reproduction, stump-sprouting, longevity, and relation to drought periods. Facts have also been gathered regarding nanism and spontaneous hybrids and attention has been paid to the behavior of trees attacked or mutilated by fire, animals, or man. Some notes have in general been added regarding the economic features of the species, especially in regard to wood characteristics; while this data is intended to be supplementary, it very commonly has a botanical as well as an economic interest.

Material for the preparation of this volume is the result of field studies and collections made by the author in nearly all parts of California during the last nineteen years. In making collections the object has been not only to gather representative material but as extensive series of variations as possible. It has also been the practice to look for extremes of variations on a single individual;

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such suites have been of the greatest service in determining the limits of species and in locating dubious material. Still another object has been to pursue the study of trees in forest areas least affected by our industrial civilization and, therefore, to push expeditions into the remoter parts of the State beyond frontier settlements, along mountain trails or through the virgin forest itself.

Not the least pleasure in connection with the field work has arisen from the acquaintance formed with mining men and ranchmen, lumbermen and woodsmen, stockmen and mountaineers. To these in all parts of California I am indebted for many courtesies extended to me as a botanical traveler and for a great amount of information concerning the country, its streams, trails, trees, and resources. Among these it is a pleasure to name Mr. Ralph Hopping, naturalist and mountaineer on the North Fork of the Kaweah; Mr. F. F. Thomas, President of the Gwin Mine Development Company, Calaveras County; Mr. C. R. Johnson, President of the Union Lumber Company, Fort Bragg; Mr. W. A. S. Foster, Manager of the Northwestern Redwood Company, Willits; and Mr. Carl Purdy of Ukiah, long time a field student of the native vegetation.

In the prosecution of the biological and taxonomic studies on the native trees the author had in the years 1906 and 1907 the advantage of assistance derived from the Adams' Fund through the Agricultural Experiment Station of the University of California. For making this coöperation possible acknowledgements are due to the courtesy of the Director, Professor E. J. Wickson.

Data concerning temperature and precipitation have been derived chiefly from the United States Weather Bureau records. All temperatures are Fahrenheit. As to rainfall, inasmuch as the resting period of plants in California is in the main from May to October, it is obvious that records of annual precipitation cannot be correlated with the phenomena of vegetation. Records of precipitation here given are therefore seasonal, having been accurately or approximately worked over from detailed annual records.

The critical diagnoses formulated in this volume rest chiefly upon sets of specimens brought together at the University of California. The illustrative material of each species is in most cases abundant although in some cases scanty. In connection with this work, the Botanic Garden of the University has furnished opportunity for some experimental cultures which have been instructive. At this juncture it is a pleasure to express my obligations to my colleague, Professor H. M. Hall, of the University of California, who has generously facilitated use of the University Herbarium and who has placed at my disposal notes on the distribution of native trees; and to my former student, Mr. J. P. Tracy, for notes on the habits of Tideland Spruce and some other trees near Eureka. In addition I have received material and notes from Mr. S. B. Parish, San Bernardino; Professor W. R. Dudley, Stanford University;

Mr. George W. Stewart, Visalia; Professor Clifton Price, University of California; Mr. M. S. Baker, Kenwood; Miss Charlotte Hoak, Los Angeles; and from many other friends and correspondents whose names find mention at proper places in the text.

In 1905-06 the leading European herbaria were visited by the author for the purpose of studying early types of the Californian flora. While engaged upon these special studies advantage was taken of the opportunity to examine tree material from California. For the privilege of an investigator it is a pleasure to express obligation to the following: Sir Isaac Bayley Balfour, King's Keeper of the Royal Botanic Garden, Edinburgh; Colonel David Prain, Director of the Royal Botanic Gardens, Kew, London; William Botting Hemsley, Esq., Keeper of the Herbarium, Royal Botanic Gardens, Kew, London; Dr. A. B. Rendle, Keeper, and E. G. Baker, Esq., Assistant, National Herbarium, Natural History Department of the British Museum, South Kensington, London; and Dr. Adolf Engler, Director of the Royal Botanic Gardens, Berlin.

The line drawings in illustration of this paper are mainly the work of the late Miss M. H. Swift. Her studies of the Sugar Pine, Monterey Pine, and Red Fir cones, Valley Oak acorns, and other pen and ink drawings signed by her initials will serve to indicate the special gifts of this botanical artist and the loss which western botany sustained in her death. Some of the remaining drawings were made by Dr. A. A. Lawson of the University of Glasgow, Scotland; by Eloise Roorbach of Brookdale, California; by Mr. A. J. Heindl, Berkeley; and by Mrs. Louise Nash, Berkeley. The drawings should be understood as being natural size unless otherwise stated.

The photographic illustrations are largely my own, but the credit for their value should go chiefly to the University photographer, Mr. B. F. White, who is responsible for the prints. For the remaining photographs I am indebted to the following: Dr. W. A. Setchell, Professor of Botany in the University of California; Dr. G. K. Gilbert, U. S. Geological Survey; Mr. L. E. Hunt, San Francisco; Mr. A. W. Ericson, Arcata, who has made most excellent pictures of the Redwood industry; Mr. C. G. Pierce, Los Angeles, notable for his successful photographic studies of the Washington Palms and other desert trees; Professor Pliny E. Goddard, now of the American Museum of Natural History, New York, my companion on the Hupa-Salmon River Expedition in 1902; and some others whose names appear on the explanation of plates.

Willis Linn Jepson.

University of California,
Berkeley, April 25, 1907.

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## ERRATA.

Page 17, paragraph 2, line 14. *For* Incense Fir *read* Incense Cedar.

Page 83. *For* **Pinus contorta** Don *read* **Pinus contorta** Dougl.
(In the bibliography the first line should read "PINUS CONTORTA Dougl. in Loudon," etc.)

Page 102, paragraph 3, line 2. *For* John Coulter *read* Thomas Coulter.

Page 259. *For* **Cercidium Torreyanum** Wats. *read* **Cercidium Torreyanum** Sarg.

Page 272. *For* **Arbutus Menziesii** Hook. *read* **Arbutus Menziesii** Pursh.

Page 281. *Chilopsis linearis* should be italicized, as a synonym.

# GEOGRAPHICAL DISTRIBUTION OF CALIFORNIA TREES.

## Silva Californiana.—Forest Provinces.

The earliest European voyagers to sail northward along the coast of California saw little but bold barren hills rising from the shore line—exactly what is, in general, seen today. For two hundred years sea adventurers came and went but told no tales of great woodlands or forested mountains. The existence of forests was not even guessed. The very name of the land was against the thought, for the idea of furnace-like heat is in some way connected with most of the legends and interpretations gathered about the word California. The earliest explorers by land, Spaniards from Old Mexico, met treeless deserts and sun-scarred foothills, through which they came, however, to places adapted for settlement in oak-studded valleys lying near the sea.

With settlement accumulated local knowledge concerning the trees, but it was not until the coming of the scientific explorers, Douglas and Nuttall, Fremont and Kellogg, Brewer and Bolander, that the world obtained definite knowledge of the land's forest resources. Even today scientific knowledge of the forests of California is still in its infancy, although it can now be said that we have here the most remarkable development of coniferous forests to be found anywhere. While this statement is not true as to any one characteristic, it is believed to be true as to the sum total of their characteristics, their richness in species, the features of their geographical distribution, their biological history, and their commercial value both as to relative quantity and actual quality.

The geographical distribution of forests depends upon rainfall, temperature, insolation, soil, exposure, and winds, and these factors in California are most largely regulated by the direction and height of the mountain ranges, by distance from the ocean and in a less degree by latitude.

Two mountain systems, the Coast Ranges on the west and the Sierra Nevada on the east, enclose a long oval plain, the northerly portion of which is known as the Sacramento Valley, the southerly portion as the San Joaquin Valley, each drained by a river of the same name. The two rivers meet near the middle of the "Great Valley" and run into a series of bays, San Francisco Bay and its connecting arms, which break through the Coast Ranges to the Pacific Ocean.

The Coast Ranges consist of a series of ranges in a general way paralleling the ocean. The North Coast Ranges and the South Coast Ranges are so different forestrally that they are here considered as two distinct forest provinces. Southern California in biological character belongs to the desert region and is thus treated as a separate province with distinctive characteristics. We have,

therefore, five forest provinces in California: 1. Sacramento and San Joaquin valleys; 2. South Coast Ranges; 3. North Coast Ranges; 4. Sierra Nevada; 5. Southern California. The latter province, Southern California, is taken to include the counties of Santa Barbara and San Bernardino and southward. The Sierra Nevada province includes the range of that name south to the Tehachapi Mountains and north to Mt. Shasta with its westerly foothills and the country east to the State line.

### Sacramento and San Joaquin Valleys.

The Sacramento Valley and the San Joaquin Valley really form one "Great Valley" about 400 miles long with an average width of fifty miles. "Great Valley" is a term frequently used in the following pages. It has been at intervals (in the Pliocene Age and in previous ages) the bed of an inland sea, and is almost level, with an average elevation of 10 to 300 feet above the ocean. Its surface is covered, to varying depths, with alluvial loam, adobe, clay, alkaline, gravelly or sandy soils, which often change abruptly and repeatedly within short distances.

Extensive treeless areas are the most characteristic feature of the Sacramento and San Joaquin valleys. The wooded areas are thin and limited in extent. The east side of the Sacramento and San Joaquin valleys supports the greater part of the groves of scattered trees as contrasted with the west side which is in the main treeless. Wherever trees are found on the plains proper, east side or west side, they are generally associated with the alluvial loams. This fact is related to the presence or absence of living streams and the mountain ranges in which the streams originate. On the east side of the "Great Valley" large rivers, emerging from the Sierra Nevada and flowing across the plains to the main arteries in the center of the valley, have built up alluvial deltas or have covered the plains with strata of the finest loam. The broad alluvial banks of these streams are often higher than the country lying behind them, particularly towards the foothills, and support open groves of Valley Oak and Interior Live Oak, which in some cases, although rarely, spread as a scattered growth over the inter-riparian plains. The west side of the San Joaquin and Sacramento valleys is similarly traversed by streams emerging from the Coast Ranges. While these are flood rivers in winter, they present dry beds in summer or towards the north only feeble streams. Wherever such streams have built up broad alluvial banks, as along Cache, Putah, Ulatis and Alamo creeks, they support groves of scattered trees of the characteristic species named above.

Viewed broadly the plains of the "Great Valley" are all but treeless, supporting nothing that can be called a true forest, unless a partial exception be made of the great oak grove of the Kaweah delta. The explanation of this treeless character is to be sought partly in the nature of the soils, and partly in

the peculiarity of the seasons and seasonal distribution of the rains. Certain areas are, of course, too alkaline or too sandy to grow native trees. Extensive areas, too, are covered with adobe soil. While the adobe grows heavy stands of exotics under man's care, its physical peculiarities discourage the attempts of the native trees to gain a foothold upon it. Adobe is a black clay, rich in the sense that it possesses lasting strength, but heavy and sticky, running together in a heavy mass during the rains and parting into cracks one-fourth to three or four inches wide and one to two feet deep in the rainless season. It is thus plainly impossible for an unassisted seedling to carry itself over to a second winter, as it cannot get its roots far enough down to avoid dessication. In the extreme type, the "blue adobe," this cracking of the soil is a curious feature on the uncultivated lands in the dry months.

Clays do not crack so much in the dry season as adobe, and loams still less, but the drying out of the soil accounts in part for the absence of trees on these soils, as also scanty rainfall or intermittent dry years, the effects of hot north winds at critical periods, or the attacks of browsing animals. All of the above reasons are not, however, sufficient to account for complete absence of trees over wide areas, especially on the alluvial soils where the conditions are as perfect for the maintenance of trees as in similar areas where there are fine stands of Valley Oak or the Interior Live Oak. Why are the plains treeless, is a question repeatedly asked. An understanding of the problem can only be had historically, by a consideration of the former annual vegetation and the habits of the California Indians. The herbaceous vegetation in aboriginal days grew with the utmost rankness, so rank as to excite the wonderment of the first whites, who repeatedly tell of tying wild oats or grasses over the backs of their riding horses. This dense growth was usually burned each year by the native tribes, making a quick hot fire sufficiently destructive to kill seedlings, although doing little injury to established or even quite young trees. It was, therefore, only in certain years as a result of a combination of local conditions or indirect influences now only to be guessed, such as the character of seasonal rainfall, winds, fire, flood or pestilence, that germinating seedlings were enabled to persist in particular areas. The presence, therefore, of groves of oaks is rather to be explained than their absence. It is noteworthy, then, that on the plains proper the groves or scattered trees were always of two species, the Valley Oak and Interior Live Oak. These species when once established are well adapted by their thick bark to withstand grass fires, while their scattered method of growth,[1] so characteristic everywhere in the Great Valley, is undoubtedly the result of repeated annual fires. On creek banks or in river bottoms, where on the other hand the soil is wet and grass green all summer, we usually find dense stands composed of the characteristic Willows, Cottonwoods and other

[1] Compare plate 14.

trees. The main rivers, especially, are marked by a dense arboreous fringe consisting of Black Willow, Red Willow, Yellow Willow, Box Elder, Common Cottonwood, Oregon Ash, Interior Live Oak, Valley Oak, and often with extensive areas of marsh lands filled with tule lying back of their alluvial banks.

The relation of rainfall and temperature to the phenomena of active vegetation is exceptionally marked in the Great Valley. As is the case generally in California at the lower altitudes, there are but two seasons, the rainy season lasting from November to April, and the dry season lasting from May to October. During the dry season in the Great Valley the temperature ranges high, from about 60° to 110°, in the hottest months and with very dry air. During the wet season the rainfall averages 10 to 20 inches, while the range of temperature is about 33° to 75°, seldom falling to 26°, rarely to 18°. The climatic conditions may be more specifically set forth by a tabulation of the records for five years at Modesto, which lies almost in the center of the Great Valley and may be taken as a typical station.

TEMPERATURE AND PRECIPITATION AT MODESTO.*

July, 1903-June, 1908. Elevation, 90 feet.

| | TEMPERATURE. Monthly Maximums and Minimums, Fahrenheit. | | | | | PRECIPITATION (in inches). | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 |
| July | 103-60 | 106-63 | 110-60 | 109-70 | 98-82 | .00 | .00 | .00 | .00 | .00 |
| Aug. | 105-60 | 108-60 | 105-60 | 106-60 | 101-80 | .00 | 0.13 | .00 | .00 | .00 |
| Sept. | 110-55 | 108-56 | 104-59 | 102-60 | 104-80 | .00 | 1.68 | .00 | .00 | .00 |
| Oct. | 101-49 | 98-41 | 102-45 | 106-47 | 90-50 | .00 | 0.30 | .00 | .00 | 1.50 |
| Nov. | 80-40 | 89-44 | 90-39 | 89-34 | 70-38 | 2.64 | 0.50 | 0.61 | 1.02 | .06 |
| Dec. | 72-32 | 78-36 | 84-30 | 84-33 | 60-38 | 0.17 | 1.31 | 0.89 | 4.89 | 2.02 |
| Jan. | 71-32 | 70-38 | 81-34 | 79-30 | 65-35 | 0.33 | 4.01 | 2.28 | 4.11 | 3.99 |
| Feb. | 75-34 | 84-35 | 85-40 | 79-43 | 65-35 | 1.67 | 1.87 | 1.98 | 3.00 | 1.18 |
| March | 75-40 | 86-44 | 84-45 | 79-40 | 82-40 | 2.15 | 3.50 | 3.87 | 4.70 | 0.71 |
| April | 87-41 | 92-49 | 89-53 | 90-55 | 88-54 | 1.76 | 0.67 | 1.15 | 0.10 | .00 |
| May | 103-50 | 100-49 | 86-52 | 94-60 | 92-55 | .00 | 1.80 | 1.24 | 0.18 | 0.33 |
| June | 104-55 | 99-60 | 102-53 | 98-69 | 102-63 | .00 | .00 | 0.53 | 1.04 | .00 |
| Year | 110-32 | 108-35 | 110-30 | 109-30 | 104-35 | 8.72 | 15.77 | 12.55 | 19.04 | 9.79 |

* The figures for temperature in this and the following tables are the absolute maximums and minimums, since these are the temperatures, not the mean temperatures, which are of greatest significance in relation to plant growth. Similarly the figures for precipitation are seasonal and not annual as commonly given in the Weather Bureau reports, for the reason that the period of active vegetation begins with the rains and the period of rest is the hot dry summer.

### SOUTH COAST RANGES.

The South Coast Ranges, lying south of San Francisco Bay, have an average height of 2000 to 5000 feet, except in the extreme south, where they increase in altitude. Many valleys, more or less wooded with Live Oak, Valley Oak and

Blue Oak, lie between them.[2] The Santa Cruz Mountains and Santa Lucia Mountains, facing the ocean, are forested with Redwood, Douglas Fir, Tan Oak, Madroña, and a few other species. A much scattered growth of Digger Pine covers the lower slopes of Mount Diablo. This species is the pine most commonly met with everywhere southward at the lower elevations. There are no other conifers in the Mount Diablo range save scattered bushes of the California Juniper and a few scrubs of the Knob-cone Pine in the Moraga Valley region. Yellow Pine grows on the summits of the Mount Hamilton Range as it does on all high summits southward to the mountain ranges of Santa Barbara County, where there are fine forests of this species mingled with White Fir and Incense Cedar. As a whole the South Coast Ranges are wooded only with scattered groves of Live Oak or Blue Oak, or more commonly present hundreds of miles of barren hills.

Long, dry, rainless summers and scant rainfall in winter are the broadest factors in the barrenness of these hills, but local conditions also play a part, as indicated by the signal contrast between the wooded slopes of one side of a mountain and the absolute barrenness of the other. The baked earth of south and west slopes where the sun's most intense heat is concentrated holds far less moisture than the protected north and east slopes, where springs may survive the summer. The trade winds from the ocean during the summer uniformly kill out seedlings on exposed hills where they blow with great velocity. Other areas are treeless because seed is not distributed or, again, seed dispersal may not occur in favorable years.

This element of seed dispersion, as well as that of seed production and vitality, is one of much importance in relation to the geographical distribution of native trees, and is necessarily involved in any explanation of the treelessness of the barren plains and the barren areas in the foothill country. Production and dispersion of seed are biological factors only secondary to the physical factors of rainfall and temperature and give rise to pertinent observations. Natural seeding of the barren areas under consideration could only in most reasonable likelihood have come from extension of contiguous wooded areas. Such wooded areas consist of a very thin stand of trees, chiefly oaks of the following species: Coast Live Oak, Interior Live Oak, Blue Oak, and Valley Oak. Their fruits are, however, relatively to other native trees, large and heavy and not readily dispersed, and the chances for the extension of these species are still further restricted by the following considerations. Every second or third year on the average a given tree produces no acorns or a light crop; squirrels, wild pigeons and woodpeckers may and often do draw heavily on the trees' production; excessively hot weather just before or at maturation may result in the scalding of the acorns; and a long dry autumn following the

[2] Plate 1 shows a typical oak-wooded valley of this region.

maturation of the acorns may affect unfavorably their germinating power. When the various possibilities as to the fortunes of the acorns are aligned with the possible fluctuations in rainfall and temperature, it is obvious that the problem becomes complicated. I have seen a full crop of ripe acorns in a grove of Coast Live Oak germinate while still on the trees during a short period of warm wet fall weather. A period of hot dry weather followed, killing the acorns either before or after falling.

Although many kinds of trees, native and foreign, can readily be grown by man on the barren hills of the South Coast Ranges, it is not likely that any considerable extension of wooded areas will ever occur naturally. The balance of conditions due to low annual rainfall is even now very delicate, while in primitive times the annual fires were a continued menace to the life of seedlings standing in the high dry grass.

While the inner Coast Range (facing the San Joaquin Valley) has but four arboreous conifers, the seaward ranges, where the rainfall is higher, exhibit a splendid total of thirteen species, some being species of wide range, others remarkably restricted in their habitats. The species of wide range are the Yellow Pine, Digger Pine, Douglas Fir, Redwood, California Nutmeg and Western Yew. The local species are all strictly littoral,—confined to the immediate neighborhood of the ocean, and make the south coast shore of California remarkably interesting in plant geography. They are as follows:

The Monterey Pine is a shore species and has a mainland range of 130 miles, but occurs only in a few separated localities (Fig. 1). The Torrey Pine is limited to a few square miles of the San Diego coast and to Santa Rosa Island. The Bishop Pine is another strictly coastal conifer. The Santa Lucia Fir grows only in the Santa Lucia Range overhanging the Pacific Ocean. The Gowen Cypress is a shore species occuring at Monterey and on the Mendocino Coast. The Monterey Cypress, the most local of all, grows on the bold shores at the mouth of the Carmel River and not elsewhere (Fig. 1), although very closely allied forms of the Sargent Cypress grow in the Coast Ranges.

These extremely local species offer interesting problems. Evidence is available to show that some of them, and probably all, had at one time a greater range than at present and that they are now living under changed climatic conditions. While geologists are not agreed as to the period of oscillations of the Coast Ranges, it seems very certain that the Santa Barbara Islands were connected with the South Coast Ranges during part of the Pleistocene and offered an area for plant habitation of great extent compared with the unsubmerged remnants of the present islands. The climate was then very different, since the mammoth, the bones of which are found on Santa Rosa and in great abundance on San Nicolas, and other animals inhabited the area. The conditions for plant life on the islands are even at the present time changing rapidly. Many species are becoming extinct or are represented by only a few individuals.

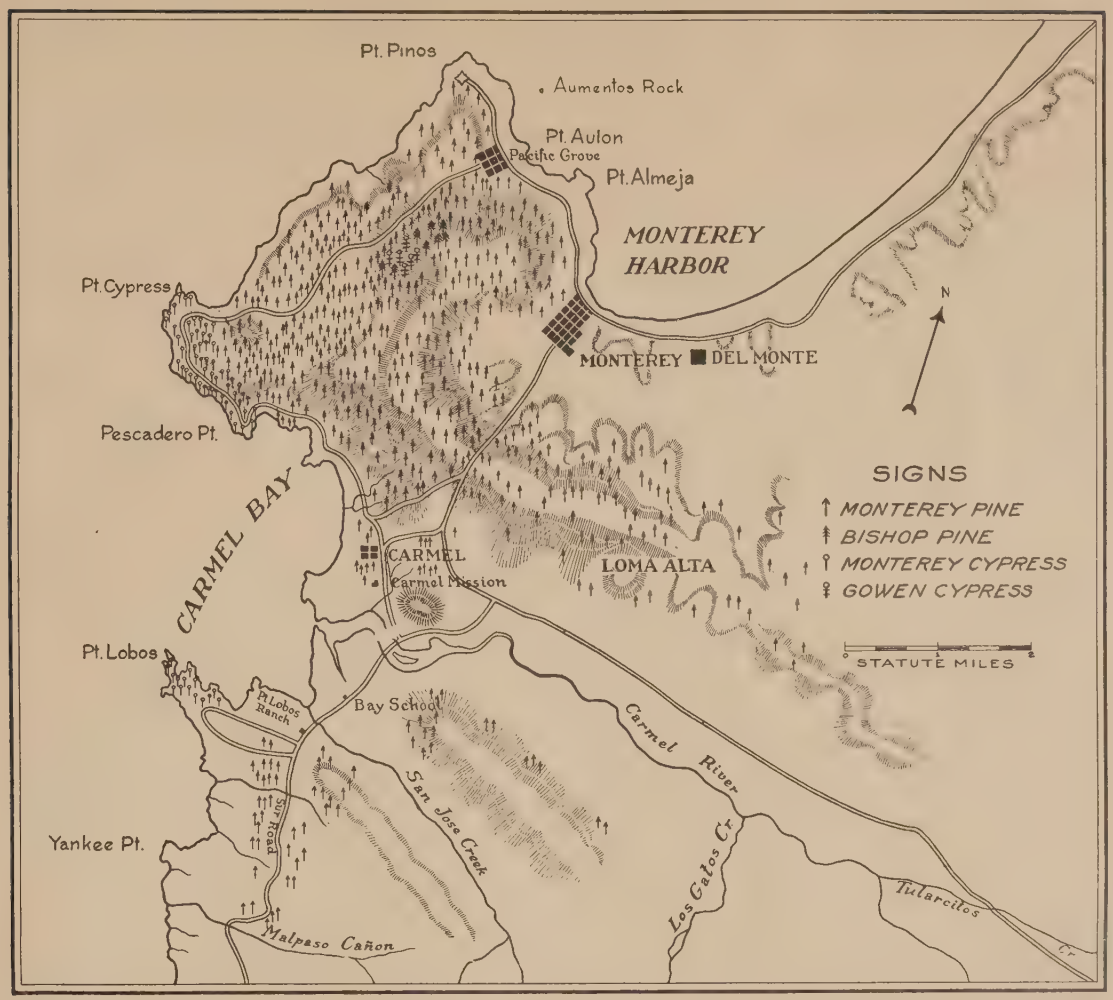


Fig. 1. An isolated arboreal island. Sketch-map of region about Monterey showing local distribution of four conifers of restricted range. *Pinus radiata* Don (Monterey Pine) recurs on the coast sixty miles to the north and seventy miles to the south. *Pinus muricata* Don (Bishop Pine) recurs on the coast eighty-five miles to the north and eighty miles to the south. *Cupressus macrocarpa* Hartw. (Monterey Cypress) is not found elsewhere. *Cupressus Goveniana* Murr. (Gowen Cypress) recurs on the coast two hundred and sixteen miles northward. See page 14.

The climate of the South Coast Ranges may be illustrated by the records at San Luis Obispo for a period of five years. The highest temperature on record is 106° and the lowest 22°. The range of temperature is great; according to the United States Weather Bureau "daily ranges of 40° or more are not infrequent." The normal annual precipitation up to 1908 was 21.52 inches. This is about ten inches higher than in the inner South Coast Ranges and six inches higher than at Monterey. The highest monthly precipitation on record, 12.10 inches, occurred in January; the highest for July is .05 inch.

TEMPERATURE AND PRECIPITATION AT SAN LUIS OBISPO.

July, 1903-June, 1908. Elevation, 201 feet.

| | TEMPERATURE. Monthly Maximums and Minimums, Fahrenheit. | | | | | PRECIPITATION (in inches). | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 |
| July | 87-42 | 89-46 | 103-44 | 87-44 | 96-46 | .00 | .00 | 0.03 | .00 | .00 |
| Aug. | 94-44 | 88-45 | 96-49 | 95-47 | 87-46 | .00 | 0.06 | .00 | 0.03 | .00 |
| Sept. | 91-43 | 106-48 | 97-42 | 100-43 | 83-42 | .00 | 3.54 | .00 | 0.04 | 0.07 |
| Oct. | 97-41 | 91-46 | 93-36 | 94-35 | 90-44 | 0.02 | 1.00 | .00 | .00 | 3.23 |
| Nov. | 87-38 | 90-34 | 83-33 | 88-27 | 86-37 | 0.48 | 0.13 | 1.97 | 1.08 | 0.01 |
| Dec. | 79-32 | 82-32 | 76-26 | 81-36 | 82-37 | 0.32 | 1.72 | 0.32 | 5.14 | 3.33 |
| Jan. | 82-30 | 76-35 | 81-26 | 74-30 | 76-34 | 1.08 | 2.35 | 6.37 | 8.88 | 6.69 |
| Feb. | 74-33 | 79-34 | 83-39 | 84-37 | 79-32 | 6.79 | 7.51 | 3.48 | 2.45 | 3.59 |
| March | 79-36 | 82-37 | 82-35 | 80-34 | 84-34 | 5.13 | 4.19 | 10.85 | 6.80 | 0.79 |
| April | 96-35 | 76-41 | 90-38 | 86-38 | 89-34 | 2.97 | 0.77 | 0.71 | 0.34 | 0.14 |
| May | 84-42 | 91-38 | 77-40 | 82-37 | 86-36 | 0.20 | 2.26 | 4.22 | 0.11 | 0.21 |
| June | 96-43 | 77-44 | 100-45 | 92-41 | 92-38 | .00 | 0.03 | 0.16 | 0.02 | .00 |
| Year | 97-30 | 106-32 | 103-26 | 100-27 | 96-32 | 16.99 | 23.56 | 28.11 | 24.89 | 18.06 |

NORTH COAST RANGES.

Immediately north of San Francisco Bay lie the typical Californian valleys of Napa, Santa Rosa, Alexander, Clear Lake, Ukiah and many others, wooded with open groves of Live Oak and Valley Oak and watered by streams which flow into the Sacramento River, San Pablo Bay and the Pacific Ocean. The ridges separating these valleys and guarding them against the ocean average 2400 to 2600 feet. North of Long Valley in Mendocino County these valleys disappear, the country is very much more broken and the mountains grow higher, the highest peaks reaching 4000 to over 9000 feet. Level land is scarcely to be found save for occasional flats or narrow terraces in some river cañons, and unforested land becomes scarcer as one travels towards the coast. The terms on the maps may easily mislead. The "bald hills" of Mendocino are not bald hills but forested ranges with open spaces on their summits, or southerly or westerly slopes (Plate 2). The "prairies" of Humboldt are not flat lands reaching to the horizon, but bald spots of limited extent in a country which is strictly mountainous.

With an annual average rainfall of forty to fifty inches, with a rich soil and with an increasing control of the annual fires, the forests and woods of this whole region are showing a decidedly aggressive character and are encroaching steadily upon the barren lands. There is today more wooded area in Humboldt County than when the white man came over a half-century since. The persistent character of the North Coast Range woodlands is further explained by their capacity for vegetative reproduction, there being a large number of species which stump-sprout when the tree is overthrown by natural causes or felled

by man. The Redwood and Tan Oak are in this particular notable for often producing hundreds of shoots from a single stump. Other species which stump-sprout are the California Nutmeg, Western Yew, Black Oak, Live Oak, Maul Oak, the various Willows, California Laurel, Big-leaf Maple, Oregon Ash and Madroña.

The most marked forestral feature of this region is the Redwood Belt, which is chiefly confined to the seaward slopes of the mountains and river basins facing the ocean on the seaward Coast Range and extends south of San Francisco Bay to the Santa Lucia Mountains, being three hundred miles in length. In this belt the Redwood is everywhere the dominant tree (Plate 37), the Douglas Fir, Tan Oak, Lowland Fir, Coast Hemlock and Sitka Spruce forming but a small percentage of the stand. On the summits and easterly side of this range north of San Francisco Bay and in the ranges next eastward the country is more open, including the "bald hills" described above; only 40 to 60 per cent. of the total area is wooded, the most important trees being Douglas Fir, Tan Oak, Madroña and Oregon Oak, with a little scattering Yellow Pine. The inner Coast Range, known as the Yollo Bolly Mountains, averages 6000 to 9500 feet in altitude and supports above 4000 feet a forest belt in which the predominating trees are Yellow Pine, Sugar Pine, Incense Fir, White Fir and Red Fir. Northward this belt reappears on the high summits of the Siskiyou Mountains and as far westward as Trinity Summit. South of Clear Lake Yellow Pine and Sugar Pine grow, or at one time grew, on the highest summits of the Mt. St. Helena Range from Cobb Mountain to Howell Mountain and in some localities the Incense Cedar was associated with them.

The most southerly part of the inner North Coast Range is known as the Vaca Mountains, which is a long ridge averaging about 2200 feet in altitude. This range contains but a single conifer, namely the Digger Pine, which is, too, a widely distributed conifer of arid areas in the foothill districts of the inner and middle North Coast Ranges. While no other part of the inner Coast Range has so few coniferous species, the inner range throughout its entire length is mainly weak in species and usually in individuals.

The seaward ranges, on the contrary, are rich in species and in individuals. While the density of the forest stand near the sea is chiefly due to the remarkable development of the Redwood,[3] there are also a large number of other species, some playing an important part in the forestation of the region.

In the far North Coast Ranges two local species are found, the Weeping Spruce in the Scott and Marble mountains, and the Port Orford Cedar, ranging from the Trinity River to Coos Bay in Oregon. The Foxtail or Balfour Pine, which is local in the Scott Mountains, is also local on the headwaters of the Kern and Kings rivers in the Mt. Whitney region.

[3] Compare outer and inner ranges in relation to distribution of Redwood as diagrammatically illustrated in fig. 10, page 131.

The climatic conditions in the North Coast Range area may be most instructively brought out by a consideration of the temperature and rainfall at Eureka, which is situated on the coast in the region of greatest development of the Redwood. The following table, therefore, specifically illustrates the "Redwood climate," the low daily and seasonal range of temperature and the high rainfall. The highest recorded temperature (to 1908) is 84° and the lowest, 20° (above zero). The mean monthly temperature for July (period of record 1887-1900) is 55.7°, and for December, 48°. The normal seasonal precipitation is high, being 45.59 inches (July, 1887-June, 1900). The greatest monthly precipitation on record, 19.05 inches, occurred in March. While the dry season precipitation is inconsiderable, there is, nevertheless, usually some rainfall every month. During the period from 1887 to 1900 there were only three months without rainfall. The greatest precipitation for July on record is 0.75 inches.

TEMPERATURE AND PRECIPITATION AT EUREKA.

July, 1903-June, 1908. Elevation, 64 feet.

| | TEMPERATURE. Monthly Maximums and Minimums, Fahrenheit. | | | | | PRECIPITATION (in inches). | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 |
| July | 64-47 | 62-47 | 73-50 | 66-50 | 64-49 | 0.06 | 0.75 | 0.02 | 0.01 | .00 |
| Aug. | 66-48 | 65-48 | 66-48 | 65-47 | 65-47 | 0.53 | .00 | .00 | .01 | 2.66 |
| Sept. | 71-44 | 69-46 | 68-45 | 72-46 | 66-48 | 0.28 | 1.36 | 0.38 | 0.76 | 0.63 |
| Oct. | 72-42 | 75-41 | 73-40 | 77-39 | 70-45 | 2.42 | 2.67 | 1.50 | 0.67 | 1.48 |
| Nov. | 69-37 | 81-43 | 70-37 | 67-33 | 67-38 | 10.79 | 4.41 | 3.93 | 3.13 | 2.38 |
| Dec. | 64-35 | 61-33 | 63-32 | 63-36 | 70-34 | 4.03 | 8.18 | 4.32 | 7.59 | 8.59 |
| Jan. | 59-32 | 65-37 | 68-31 | 60-33 | 67-34 | 5.24 | 4.81 | 7.63 | 10.40 | 7.23 |
| Feb. | 56-33 | 66-31 | 68-38 | 65-35 | 60-33 | 16.10 | 0.99 | 6.27 | 10.57 | 6.59 |
| March | 64-36 | 77-38 | 71-33 | 62-35 | 63-33 | 19.05 | 7.28 | 7.72 | 11.83 | 2.82 |
| April | 75-37 | 66-42 | 66-38 | 70-39 | 65-35 | 5.14 | 0.78 | 2.14 | 3.30 | 0.85 |
| May | 66-42 | 63-43 | 62-40 | 64-46 | 63-39 | 1.02 | 1.39 | 3.57 | 1.69 | 2.57 |
| June | 61-45 | 62-47 | 66-46 | 62-45 | 64-45 | 0.55 | 0.12 | 1.56 | 0.58 | 0.19 |
| Year | 75-32 | 81-31 | 73-31 | 77-33 | 70-33 | 65.21 | 32.74 | 39.04 | 50.54 | 35.99 |

SIERRA NEVADA.

The Sierra Nevada mountains define California. They, more than any other one feature, lend character to nearly the whole State, give main emphasis to its topography, its climate, its rainfall and its temperature, and furnish the majority of its perennial rivers. They are 500 miles in length and rise from the plains of the Great Valley to heights ranging from 7000 to 14,500 feet. The eastern slope is remarkably abrupt. The western slope, on the other hand, is comparatively gradual, averaging forty miles in width and is heavily forested with a great variety of coniferous species. By reason of the physical factors

the species have each their own altitudinal range and are fairly well distributed into definite forest bands or zones, particularly on the western slope.

The Foothill Region with its low annual rainfall and high summer temperatures supports, when not wholly barren, only scattered trees or open groves. (Plate 3.) The most characteristic species of the Foothill Region are the Digger Pine and Blue Oak, trees of comparatively small size. Above the Blue Oak there is usually chaparral, composed of various shrubs, or a Chamise area. The main forest begins with the Yellow Pine Belt. With the Yellow Pine is commonly associated, except at its lower limits, four other characteristic species: Incense Cedar, White Fir, Sugar Pine and Big Tree. (Plate 4.) All of the above trees are coniferous species of the first size. Above the Yellow Pine Belt is the Red Fir Belt; with the Red Fir is associated Silver Pine, Tamrac Pine and Jeffrey Pine. The Timber Line Belt includes the White-bark Pine, Mountain Hemlock and Sierra Juniper. (Plate 5.)

As a means of interpretation of the climatic influences in relation to the Yellow Pine Belt the following table is inserted. It will also serve for comparison with the table for the Great Valley and especially with that for the Redwood Belt. Blue Cañon is situated near the central part of the Sierra Nevada on the west slope, in Placer County.

TEMPERATURE AND PRECIPITATION AT BLUE CANON.

July, 1903-June, 1908. Elevation, 4695 feet.

| | TEMPERATURE. Monthly Maximums and Minimums, Fahrenheit. | | | | | PRECIPITATION (in inches). | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 |
| July | 85-46 | 89-48 | 94-36 | 87-38 | 83-35 | .00 | 0.01 | .00 | .00 | .00 |
| Aug. | 90-48 | 89-51 | 91-40 | 85-40 | 84-36 | .00 | .00 | 0.15 | .00 | .00 |
| Sept. | 88-38 | 86-35 | 84-34 | 81-35 | 84-35 | .00 | 4.57 | 0.38 | 0.50 | .00 |
| Oct. | 78-33 | 78-31 | 75-25 | 82-35 | 84-33 | 2.73 | 8.75 | 0.90 | 0.58 | 1.61 |
| Nov. | 68-27 | 72-28 | 69-20 | 69-20 | 70-22 | 23.31 | 2.81 | 4.85 | 5.05 | 0.42 |
| Dec. | 61-26 | 68-17 | 70-10 | 65-20 | 69-13 | 2.67 | 7.11 | 5.30 | 16.40 | 20.20 |
| Jan. | 60-12 | 61-19 | 65-17 | 63-12 | 64-22 | 4.81 | 6.24 | 24.73 | 13.18 | 6.77 |
| Feb. | 58-15 | 67-10 | 68-28 | 70-30 | 69-18 | 30.61 | 7.56 | 11.24 | 17.95 | 5.40 |
| March | 55-26 | 69-22 | 64-14 | 63-18 | 68-14 | 26.14 | 12.45 | 21.28 | 35.11 | 6.00 |
| April | 78-30 | 68-25 | 70-15 | 85-20 | 80-21 | 7.59 | 2.70 | 7.42 | 2.59 | 2.45 |
| May | 84-33 | 79-30 | 75-25 | 77-10 | 72-24 | 1.00 | 5.61 | 12.59 | 4.52 | 4.95 |
| June | 87-53 | 80-32 | 80-29 | 81-30 | 82-28 | 0.08 | 0.51 | 4.42 | 4.59 | 1.25 |
| Year | 90-12 | 89-10 | 94-10 | 87-10 | 84-13 | 98.94 | 58.32 | 93.26 | 100.47 | 49.05 |

### Southern California.

The mountains of Southern California blend with the South Coast Ranges or towards the Colorado Desert consist of isolated ranges. The traveller, journeying across country between these ranges with their barren or chaparral-covered slopes, would rarely guess that forests existed in this part of California, and yet all of the ranges exceeding 4000 to 5000 feet altitude possess important woodlands in their mountain valleys, cañons and protected slopes. The species are chiefly Yellow Pine, White Fir, Incense Cedar, Jeffrey Pine, Coulter Pine and Desert Fir, and form forests with a very open stand. Such forests are characteristic of the summits of the San Gabriel, San Bernardino, San Jacinto, Santa Rosa, Santa Ana, Palomar and Cuyamaca mountains, although the species named are not common to all of these ranges. On the lower edge of the coniferous belt there occur California Black Oak and Maul Oak. Washington Palms are locally characteristic of restricted areas on the westerly side of the Colorado Desert (Plates 6, 55). The study of the northern species in this region is an attractive one because of their behavior under conditions which are less favorable, particularly in decreasing rainfall, as one moves southward.

The islands off the coast likewise belong to this area on account of their aridity, and are remarkable for the number of insular species or varieties which inhabit them. These include the anomalous Catalina Ironwood with its fern-like foliage, the Island Oak and various shrubs.

The stress of aridity affects even more unfavorably the desert trees which, although distinctly arborescent, are small. The most important desert types are the Palo Verde, Mesquite, Screw Bean, Smoke Tree, Desert Ironwood, Desert Willow and Tree Yucca.

The climatic factors to which these latter species are subject is best illustrated by the temperature and rainfall data from some station on the desert. Indio, Riverside County, is chosen because it lies in the Colorado Desert about midway between the Pacific Ocean and the Colorado River and has the general climatic characteristics of the whole desert region in this area. The normal "annual precipitation" at Indio (to 1908) is 2.42 inches; at Salton (to 1905), 2.58 inches; at Needles (to 1905) 2.77 inches. The statement is frequently seen that there are "many places on the desert where rain never falls." There was no rain at Salton during the season 1905-06 except a trace, and such cases may not be unusual, but the few stations for which there are available records do not bear out so wide a generalization.

TEMPERATURE AND PRECIPITATION AT INDIO.

July, 1903-June, 1908. Elevation, —20 feet (*i.e.*, below sea-level.)

| | TEMPERATURE. Monthly Maximums and Minimums, Fahrenheit. | | | | | PRECIPITATION (in inches). | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Month | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 | 1903-4 | 1904-5 | 1905-6 | 1906-7 | 1907-8 |
| July | 116-70 | 116-72 | 125-67 | 120-71 | 120-64 | .00 | .00 | .00 | .00 | .00 |
| Aug. | 118-48 | ..... | 116-69 | 116-67 | 112-65 | 0.10 | 0.33 | .00 | 1.07 | .00 |
| Sept. | 118-56 | 112-67 | 110-48 | 109-58 | 114-57 | 0.12 | .00 | .00 | 0.04 | .00 |
| Oct. | 105-50 | 92-67 | 106-45 | 109-40 | 101-56 | .00 | .00 | .00 | .00 | 1.60 |
| Nov. | 97-36 | ..... | 87-30 | 98-28 | 92-37 | .00 | ..... | 1.06 | 0.60 | .05 |
| Dec. | ..... | ..... | 79-20 | 81-32 | 85-31 | ..... | ..... | 0.14 | 1.89 | .00 |
| Jan. | ..... | ..... | 83-23 | 80-30 | 82-34 | ..... | ..... | .00 | 0.59 | 0.95 |
| Feb. | ..... | 78-38 | 88-42 | 90-38 | 87-30 | ..... | 2.00 | 0.97 | 0.63 | 0.57 |
| March | ..... | 89-43 | 90-39 | 94-39 | 93-37 | ..... | 1.30 | 2.06 | 0.96 | 0.01 |
| April | 110-43 | 93-45 | 98-42 | 103-47 | 103-45 | .00 | .00 | 0.47 | .00 | .00 |
| May | 113-43 | 107-47 | 101-55 | 102-57 | 100-48 | .00 | .00 | .00 | .05 | .00 |
| June | 116-62 | 110-64 | 114-62 | 117-55 | 112-57 | .00 | .00 | .00 | .00 | .00 |
| Year | 118-36 | 116-38 | 125-20 | 120-28 | 120-31 | 0.22 | 3.63 | 4.70 | 5.83 | 3.18 |

## TREE ZONES IN CALIFORNIA.

The occurrence of forests and the distribution of the species composing them depend upon such factors as rainfall, temperature, soil, exposure and winds. Rainfall is the most important factor and increases about two-fifths of an inch with each one hundred feet of altitude. Along the Pacific Coast it also varies with the latitude, being greater towards the north. The temperature, of course, decreases with increase of altitude and varies with the latitude, being higher towards the south. Soil and exposure are less important factors, while the effect of winds is most noticeable in unprotected situations or on certain slopes. By reason of the physical factors the State may be set off into fairly well-marked altitudinal zones, following the nomenclature of C. Hart Merriam. These, with their physical features and characteristic arboreous species, may be concisely summarized as in the following tabulation. The figures for altitudes are broad averages; for temperature, mean annual temperatures.

### SONORAN ZONE.

Altitude, sea-level to 2000 feet; temperature, 60° to 75°; rainfall, 1 to 15 inches. Area, the desert and valley levels and hot foothills.

(*a*) Desert Sonoran,—Tree Yucca, Fan Palm.

(*b*) Valley Sonoran,—Valley Oak, Live Oak.

(*c*) Foothill Sonoran,—Blue Oak, Digger Pine.

(*d*) Chaparral Sonoran,—Nuttall Ceanothus, Chamise, and other shrubs.

### Transition Zone.

Sierra Transition, altitude, 2000 to 5000 feet; temperature, 55° to 60°; rainfall, 25 to 35 inches. Yellow Pine, Incense Cedar, White Fir, Sugar Pine, Big Tree.

Coast Range Transition. (*a*) Yellow Pine area, altitude 2000 to 5000 feet; temperature 50°; rainfall, 30 to 40 inches. Yellow Pine, Tan Oak, Black Oak. (*b*) Redwood area, altitude sea-level to 2000 feet; temperature 55°; rainfall 40 to 70 inches. Redwood, Tideland Spruce, Coast Hemlock. While the Yellow Pine Belt of the Coast Ranges is altitudinally higher than the Redwood Belt, it is physiologically lower. That is to say, proceeding from the hot, dry Great Valley towards the coast is, viewed from the standpoint of the combined physiological factors, broadly similar to ascending the Sierra Nevada.

### Canadian Zone.

Sierra Nevada, altitude 5000 to 7000 feet; temperature 50° to 55°; rainfall 40 to 50 inches. Red Fir, Silver Pine, Tamrac Pine, Jeffrey Pine. Coast Range similar, but this zone appearing only on the summits of the more elevated ranges.

### Hudsonian Zone.

Sierra Nevada, altitude 7000 to 9000 feet; temperature, 45° to 50°; rainfall, 50 to 55 inches. White-bark Pine, Mountain Hemlock, Sierra Juniper. The Coast Range Hudsonian is limited to the summits of the high Coast Ranges of the Siskiyous and Trinity.

### Boreal Zone.

Sierra Nevada, altitude 9000 to 14,500 feet; temperature, 40° to 45°; rainfall, 60 to 70 inches. Above timber line, the woody plants very low and small depressed shrubs.

## Maximum Altitudinal Ranges.

The greatest altitudinal ranges in California, and perhaps in North America, occur in the latitude of 36° to 37°, that is in south-central California. Here is the highest mountain range in the United States, the Sierra Nevada, many of its peaks rising but slightly above the main axis and reaching 13,000 to 14,500 feet. This range is protruded into a low-lying desert region, part of it below sea-level, dominated by the Sonoran flora. On account of its easy western slope and

exceedingly abrupt eastern escarpment, its deep cañons and the varying direction of the rivers, there is afforded a peculiar topography in which the zones are not sharply defined and Sonoran species find conditions of dryness, moisture, exposure, slope and soil by which they can follow tongues up into the Canadian Zone or, on the other hand, Transition species may descend below their proper zone. The conditions, therefore, favor for many species an exceptionally wide altitudinal range in one latitude. The Valley Oak and Interior Live Oak which occur at 10 to 200 feet above sea-level in the San Joaquin Valley ascend to Grouse Valley, 4500 feet, in company with Interior Live Oak, Maul Oak and Shin Oak. White Alder begins at tidewater on the San Joaquin and follows up the streams to the Middle Fork of Tule River between Moses and Magee at 8000 feet, to the first mill between Millwood and Converse Basin, 6337 feet, and to the Kaweah Marble Fork above the upper ford at 7500 feet. Black Cottonwood, which occurs on the coast a few feet above sea-level, is at Junction Meadow in the Kern Cañon, on Bubbs Creek at 8000 feet, and on the San Joaquin South Fork at nearly 9000 feet. It has therefore in one latitude a greater altitudinal range than any other North American tree. The Yellow Willow (*Salix lasiandra*) may be compared with the Black Cottonwood in extreme range. It is found on the coast and in the San Joaquin Valley only a few feet above sea-level, and on Bubbs Creek at 8500 feet. Its range is practically continuous. The Buckeye is on upper Lime Kiln Creek, southwest of Comstock Mill, at 5500 feet; also above Chubb Cave at 4500 feet. It is found as low as 600 feet in the foothills or at only a few feet above sea-level on the Sur Coast in the same latitude.

The Yellow Pine in California is also a remarkable species, ranging altitudinally from 100 feet to 7000 feet or including its variety, the Jeffrey Pine, to 9000 feet. Its altitudinal distribution is more discontinuous than that of the Black Cottonwood, although it is far more abundant in its areas of best development.

## Census of Trees of California.

### Pine Family.

| | North Coast Ranges | South Coast Ranges | Sac. and S. J. Valleys | Sierra Nevada | Southern California |
|---|---|---|---|---|---|
| Silver Pine (Pinus monticola) | × | .... | .... | × | .... |
| Sugar Pine (Pinus Lambertiana) | × | × | .... | × | × |
| White-bark Pine (Pinus albicaulis) | × | .... | .... | × | .... |
| Limber Pine (Pinus flexilis) | .... | .... | .... | × | × |
| Foxtail Pine (Pinus Balfouriana) | × | .... | .... | × | .... |
| Hickory Pine (Pinus aristata) | .... | .... | .... | × | × |
| Yellow Pine (Pinus ponderosa) | × | × | .... | × | × |
| Tamrac Pine (Pinus Murrayana) | × | .... | .... | × | × |
| Beach Pine (Pinus contorta) | × | .... | .... | .... | .... |
| Big-cone Pine (Pinus Coulteri) | .... | × | .... | .... | × |
| Digger Pine (Pinus Sabiniana) | × | × | .... | × | .... |
| Torrey Pine (Pinus Torreyana) | .... | .... | .... | .... | × |
| Parry Piñon (Pinus Parryana) | .... | .... | .... | .... | × |
| One-leaf Piñon (Pinus monophylla) | .... | .... | .... | × | × |
| Bishop Pine (Pinus muricata) | × | × | .... | .... | .... |
| Monterey Pine (Pinus radiata) | .... | × | .... | .... | × |
| Knob-cone Pine (Pinus tuberculata) | × | × | .... | × | × |
| Coast Hemlock (Tsuga heterophylla) | × | .... | .... | .... | .... |
| Mountain Hemlock (Tsuga Mertensiana) | × | .... | .... | × | .... |
| Tideland Spruce (Picea sitchensis) | × | .... | .... | .... | .... |
| Weeping Spruce (Picea Breweriana) | × | .... | .... | .... | .... |
| Douglas Fir (Pseudotsuga taxifolia) | × | × | .... | × | .... |
| Desert Fir (Pseudotsuga macrocarpa) | .... | .... | .... | .... | × |
| White Fir (Abies concolor) | × | × | .... | × | × |
| Lowland Fir (Abies grandis) | × | .... | .... | .... | .... |
| Red Fir (Abies magnifica) | × | .... | .... | × | .... |
| Noble Fir (Abies nobilis) | × | .... | .... | .... | .... |
| Santa Lucia Fir (Abies venusta) | .... | × | .... | .... | .... |

### Redwood Family.

| | | | | | |
|---|---|---|---|---|---|
| Redwood (Sequoia sempervirens) | × | × | .... | .... | .... |
| Big Tree (Sequoia gigantea) | .... | .... | .... | × | .... |

### Cypress Family.

| | | | | | |
|---|---|---|---|---|---|
| Incense Cedar (Libocedrus decurrens) | × | × | .... | × | × |
| Canoe Cedar (Thuja plicata) | × | .... | .... | .... | .... |
| Port Orford Cedar (Chamaecyparis Lawsoniana) | × | .... | .... | .... | .... |
| Gowen Cypress (Cupressus Goveniana) | × | × | .... | .... | .... |
| Monterey Cypress (Cupressus macrocarpa) | .... | × | .... | .... | .... |
| Sargent Cypress (Cupressus Sargentii) | × | × | .... | .... | .... |

CYPRESS FAMILY—*(Continued)*.

| | North Coast Ranges | South Coast Ranges | Sac. and S. J. Valleys | Sierra Nevada | Southern California |
|---|---|---|---|---|---|
| McNab Cypress (Cupressus Macnabiana) | × | | | × | |
| Modoc Cypress (Cupressus Bakeri) | | | | × | |
| California Juniper (Juniperus californica) | | × | | × | × |
| Sierra Juniper (Juniperus occidentalis) | × | | | × | × |
| **YEW FAMILY.** | | | | | |
| Western Yew (Taxus brevifolia) | × | × | | × | |
| California Nutmeg (Torreya californica) | × | × | | × | |
| **LILY FAMILY.** | | | | | |
| Tree Yucca (Yucca brevifolia) | | | | × | × |
| Mohave Spanish Dagger (Yucca mohavensis) | | × | | | × |
| **PALM FAMILY.** | | | | | |
| Washington Fan Palm (Washingtonia filifera) | | | | | × |
| **WILLOW FAMILY.** | | | | | |
| Yellow Willow (Salix lasiandra) | × | × | × | × | × |
| Red Willow (Salix laevigata) | × | × | × | × | × |
| Black Willow (Salix nigra) | | | × | × | × |
| Arroyo Willow (Salix lasiolepis) | × | × | × | × | × |
| Nuttall Willow (Salix flavescens) | × | × | | × | × |
| Velvet Willow (Salix sitchensis) | × | × | | × | |
| Common Cottonwood (Populus Fremonti) | × | × | × | × | × |
| Black Cottonwood (Populus trichocarpa) | × | × | | × | × |
| Aspen (Populus tremuloides) | | | | × | × |
| **WALNUT FAMILY.** | | | | | |
| California Walnut (Juglans californica) | | × | × | | × |
| **BIRCH FAMILY.** | | | | | |
| White Alder (Alnus rhombifolia) | × | × | × | × | × |
| Red Alder (Alnus rubra) | × | × | | | |
| Water Birch (Betula occidentalis) | × | | | × | |
| **OAK FAMILY.** | | | | | |
| Valley Oak (Quercus lobata) | × | × | × | × | |
| Oregon Oak (Quercus Garryana) | × | × | | | |
| Blue Oak (Quercus Douglasii) | × | × | | × | |
| Mesa Oak (Quercus Engelmannii) | | | | | × |
| Island Oak (Quercus tomentella) | | | | | × |
| Maul Oak (Quercus chrysolepis) | × | × | | × | × |
| Coast Live Oak (Quercus agrifolia) | × | × | | | × |
| Interior Live Oak (Quercus Wislizenii) | × | × | | × | × |
| Black Oak (Quercus Kelloggii) | × | × | | × | × |
| Giant Chinquapin (Castanea chrysophylla) | × | × | | | |
| Tan Oak (Pasania densiflora) | × | × | | × | |

| | North Coast Ranges | South Coast Ranges | Sac. and S. J. Valleys | Sierra Nevada | Southern California |
|---|---|---|---|---|---|
| **Laurel Family.** | | | | | |
| California Laurel (Umbellularia californica) | × | × | .... | × | × |
| **Plane-tree Family.** | | | | | |
| Western Sycamore (Platanus racemosa) | .... | × | × | × | × |
| **Rose Family.** | | | | | |
| Desert Mahogany (Cercocarpus ledifolius) | × | × | .... | × | × |
| Bitter Cherry (Prunus emarginata) | × | × | .... | × | × |
| Oregon Crab-apple (Pyrus rivularis) | × | .... | .... | .... | .... |
| Catalina Ironwood (Lyonothamnus floribundus) | .... | .... | .... | .... | × |
| **Pea Family.** | | | | | |
| Mesquite (Prosopis juliflora) | .... | .... | .... | .... | × |
| Screw Bean (Prosopis pubescens) | .... | .... | .... | .... | × |
| Palo Verde (Cercidium Torreyanum) | .... | ... | .... | .... | × |
| Smoke Tree (Dalea spinosa) | .... | .... | .... | .... | × |
| Desert Ironwood (Olneya Tesota) | .... | .... | .... | .... | × |
| **Cactus Family.** | | | | | |
| Suwarro (Cereus giganteus) | .... | .... | .... | .... | × |
| **Buckeye Family.** | | | | | |
| California Buckeye (Aesculus californica) | × | × | .... | × | × |
| **Maple Family.** | | | | | |
| Big-leaf Maple (Acer macrophyllum) | × | × | × | × | × |
| Box Elder (Acer Negundo var. californicum) | × | × | × | × | × |
| **Dogwood Family.** | | | | | |
| Mountain Dogwood (Cornus Nuttallii) | × | × | .... | × | × |
| **Heath Family.** | | | | | |
| Madroña (Arbutus Menziesii) | × | × | .... | × | × |
| **Ash Family.** | | | | | |
| Oregon Ash (Fraxinus oregona) | × | × | × | × | × |
| Leather-leaf Ash (Fraxinus coriacea) | .... | .... | .... | .... | × |
| Arizona Ash (Fraxinus velutina) | .... | .... | .... | .... | × |
| Dwarf Ash (Fraxinus anomala) | .... | .... | .... | .... | × |
| **Bignonia Family.** | | | | | |
| Desert Willow (Chilopsis saligna) | .... | .... | .... | .... | × |
| **Honeysuckle Family.** | | | | | |
| Blue Elderberry (Sambucus glauca) | × | × | × | × | × |
| Totals | 59 | 49 | 14 | 52 | 57 |

## Arboreous Forms of Shrubs.

In the above list of California trees I have included every species of our woody flora which, according to my judgment, may properly be called a tree. While it is easy to define the term tree and easy to define the term shrub, it is not so easy to apply the definitions, for the simple reason that there is in nature no absolute difference between a tree and a shrub. Some trees may pass through a distinctively shrub stage, as is exampled by the Blue Oak, while others may occur in their adult forms both as trees and shrubs, as is seen in the California Laurel. Any species, however, which in its typical or prevailing form displays itself as a tree with a distinct trunk and crown and takes on distinctive arboreous characteristics is here regarded as a tree.

A very considerable proportion of our characteristic shrubby species exceptionally develop tree-like individuals, but I have not included in the list shrubs which sometimes become trees because these species are not, in our sense, trees. Their typical adult forms are shrubs; it is not the normal destiny of any of them to grow into trees. The appearance of occasional individuals with exceptionally thick trunks or in arborescent form is adventitious or the result of unusual or local conditions, and they are not here listed as belonging to the silva of the State. Fremontia, Manzanita, and Sierra Plum (*Prunus subcordata*) are examples. Blue Blossom (*Ceanothus thyrsiflorus*), typically a shrub, may rarely become so large that the individual would be called a tree; I have also seen its slender poles in dense stands forced up to twenty or thirty feet, just as the herbaceous California Nettle may run up to a height of fifteen or twenty feet. Waxberry (*Myrica californica*) occasionally produces a small tree, as also a native hawthorn (*Crataegus rivularis*), Western Choke-cherry (*Prunus demissa*), Mountain Alder (*Alnus tenuifolia*), Scrub Oak (*Quercus dumosa*), Toyon (*Heteromeles arbutifolia*), June-berry (*Amelanchier alnifolia*), Burning Bush (*Euonymus occidentalis*), and Button Bush (*Cephalanthus occidentalis*).

On the other hand there are certain species which are midway and can only be arbitrarily classified as either trees or shrubs. These are of two types: one type includes Red Birch (*Betula occidentalis*), Catalina Ironwood (*Lyonothamnus floribundus*) and Desert Willow (*Chilopsis saligna*). They are pole-like, having slender crowns with slender trunks. While not properly timber trees they approach the timber tree type. The other type is represented by Red Berry (*Rhamnus crocea* var. *ilicifolia*) which is often perfectly arboreous in form even when only four to six feet in height, or by the Mohave Spanish Dagger, which is dubiously included.

Again there are species, no more than shrubs or trees of small size in California, which yet attain a dignified size beyond our borders. Mountain Dogwood (*Cornus Nuttallii*), a small tree or shrub in California, is larger north-

ward. Cascara Sagrada (*Rhamnus Purshiana*), a tree thirty-five to forty feet high in Oregon and Washington, never more than a tall shrub in California, is a better example. Cat-claw (*Acacia Greggii*), a shrub with us, is often a tree east of our borders in Arizona. In the body of the text a number of shrubs are briefly described for the sake of completing the account of a family, as in the Oak Family and the various families of Coniferae.

It is interesting that a number of species, which are typically shrubs, develop arborescent individuals most frequently southward, *i.e.,* in the more arid parts of our region. The reason for this seems to be that if the local moisture is sufficient, the tree reaps the advantage of fertile soil, increased space (or freedom from competition), and other favoring influences, and grows to large size. Under this head may be noted Islay (*Prunus ilicifolia*), Island Ceanothus (*Ceanothus velutinus* var. *arboreus*), and Spiny Ceanothus (*Ceanothus divaricatus*). Laurel Sumac (*Rhus laurina*), Sour Berry (*Rhus integrifolia*), Sugar Bush (*Rhus ovata*) are southern shrubs sometimes arborescent and exhibiting trunks six inches to one foot in diameter at the ground. While Southern California is weak in number of individuals (*i.e.,* in forests), it is rich in species, *i.e.,* in the number of arboreous and arborescent forms.

## The Five Forest Provinces.

The number of species in California which may certainly be called trees is ninety-two. It will be seen that the five natural forest provinces, Sierra Nevada, Great Valley, North Coast Ranges, South Coast Ranges and Southern California, differ not only in the character of their forests, but in composition and in species. In determining the number of trees in a province no account is taken of a few exceptions where a few individuals of a species stray over the border of the province.

The North Coast Range region with fifty-nine species possesses the richest forest flora, a richness which is mainly attributable to the large number of species from the great northwest forest of Oregon and Washington which here mingle with the typically Californian species. On the other hand it receives from the South Coast Ranges no species from that region unless we except the Sargent Cypress, Coast Live Oak and Cottonwood. One species, the Weeping Spruce, is strictly local and the McNab Cypress is all but confined to the region, ranging only into the northern Sierras. Most of the species occur in great quantity, while a remarkable number, like the California Nutmeg, Digger Pine, Redwood, McNab Cypress, White Alder, Giant Chinquapin, Maul Oak and Black Oak, attain here their greatest size. Forty-six, perhaps fifty-one, of these species occur in Mendocino County within a radius of twenty miles!

Although the forests and wooded areas of the South Coast Ranges are limited, especially as compared with the North Coast Ranges, it has forty-nine species, nearly as many as the latter region. This large number of species may

be explained by three considerations: First, an exceptional number of local species, as Monterey Pine, Santa Lucia Fir, and Monterey Cypress. Second, the large number of typically North Coast or northern species, such as the Western Yew, California Nutmeg, Redwood, Knob-cone Pine, Bishop Pine, Red Alder, Giant Chinquapin, Tan Oak, Oregon Oak, California Laurel and Madroña, which range southward into restricted areas,—*i. e.,* the Santa Cruz and Santa Lucia mountains. Third, the mixture of typically southern species such as Coulter Pine and Sycamore with typical Californian species.

The Great Valley or region of the Sacramento and San Joaquin is of the five areas the weakest in species, numbering only fourteen. This fact is due to its low annual rainfall, long dry summers and various other factors discussed on page 11. Such tree growth as it possesses is mainly confined to the river banks and bottoms, and moist alluvial plains.

Southern California possesses fifty-seven species, a large number for an arid region. The typical species are, of course, desert types such as the One-leaf Piñon, Parry Piñon, Limber Pine, Hickory Pine, Big-cone Pine, Joshua Tree, Washington Palm. Many northern forms appear on the mountain tops; in this category would fall the Yellow Pine, Sugar Pine, White Fir, Incense Cedar and Tamrac Pine, while others, such as the Maul Oak, Black Oak, California Laurel, Big-leaf Maple, Mountain Dogwood, Madroña and Oregon Ash, occur at lesser elevations and, with the exception of the first two, very sparingly. The Desert Fir, Torrey Pine and Tree Yucca are peculiar to the region.

The Sierra Nevada forms the most extensive and most important forest region of the State. It includes fifty-two species, which are mostly typical Californian species, many of which attain in this great range their highest development. A few species, the Tan Oak, Madroña, and Knob-cone Pine, are typical North Coast Range forms which enter the region by means of the Shasta cross range in the north. Two species, the Limber Pine and One-leaf Piñon, are desert types appearing in favorable situations in the southern part of the range. There is only one peculiar species, namely, the Big Tree.

### Typically Californian Species.

The number of species that may be called typically Californian is large—namely, forty-nine. Typically Californian in the sense that they are the most characteristic species of the forests of the State, that they are here most highly developed and (with some exceptions) range no great distance beyond its borders or only in a feeble or uncertain manner. Among the exceptions should be noted the Yellow Pine and White Fir, which cover a wide territory in the western United States. Many typically Californian species, especially oaks and conifers, reappear on Mt. San Pedro Martir in Lower California, while a larger number, especially conifers, range northward into Oregon. The species strictly peculiar to California are marked with an asterisk and number eighteen.

California Nutmeg.*
Foxtail Pine.*
Silver Pine.
Sugar Pine.
Yellow Pine.
Big-cone Pine.*
Digger Pine.
Torrey Pine.*
Knob-cone Pine.
Monterey Pine.*
Bishop Pine.
Weeping Spruce.
Desert Fir.*
White Fir.
Red Fir.
Santa Lucia Fir.*
Big Tree.*
Redwood.
Incense Cedar.
Monterey Cypress.*
Gowen Cypress.*
McNab Cypress.*
Sargent Cypress.*
Modoc Cypress.*
Sierra Juniper.
California Juniper.
Tree Yucca
Mohave Spanish Dagger.
Washington Palm.
California Walnut.*
Yellow Willow.
Red Willow.
Arroyo Willow.
Common Cottonwood.
White Alder.
Valley Oak.*
Blue Oak.*
Maul Oak.
Coast Live Oak.
Interior Live Oak.
Black Oak.
Mesa Oak.
Tan Oak.
Giant Chinquapin.
Western Sycamore.
California Buckeye.*
Catalina Ironwood.*
Madroña.
Blue Elderberry

Species not included in the above list are mainly typical of the great northwest forest or of the southwestern deserts. Some of them have a wide range eastward into the Rocky Mountains, others follow the coast northward to British Columbia, a few of them reaching southeastern Alaska.

### California and Eastern United States.

The forests of California and those of the Eastern United States offer very broad and striking contrasts. In California the cone-bearing species are so abundant, both in species and individuals, that the forests are exclusively or mainly coniferous. The broad-leaved trees, which are mainly evergreen, are comparatively rich in species but exceedingly weak in individuals. The most typically Californian and the most abundant are the Live Oak, Valley Oak, Blue Oak, Tan Oak, California Laurel and Madroña. We have no hickories (of which there are eight species in the Eastern United States), no elms, no beeches, no true chestnuts, and but one walnut and that feebly developed in individuals and restricted in range. Many species are exceedingly local and even the most abundant and most typical are confined to very definite areas. People may and do live in the State for fifty years, and travel from one end to the other, without seeing either a Redwood or Big Tree.

The broad-leaved forests of the Eastern United States, on the other hand, originally covered the whole country, and the characteristic walnuts, hickories, oaks, beeches, chestnuts and elms are still everywhere familiar.

There are only two species of trees common to California and the Eastern United States. These are the Aspen and Black Willow, species of wide distribution. The Aspen, furthermore, is the only species of the Californian silva which reaches the Arctic Circle.

# DENDROLOGICAL CHARACTERISTICS OF CALIFORNIA TREES.

## Mutilation and Regeneration.

Coniferous trees, as is well known, do not sprout from the stump when cut down, although there are a few exceptions to this general rule. The most notable is that of the Coast Redwood which stump-sprouts very freely, the sprouts frequently numbering a hundred or more, and forming a circle about the great parent stump. The sprouts compete for light as do seedling trees and the survivors grow into tall trees. These when cut leave a circle of stumps and, chiefly on the exterior of this original circle, another circle of sprouts arises.[4] There is an idea current among woodsmen that second-growth trees do not make good Redwood lumber, yet the mature trees of the first class in the virgin forest originated in a large degree as stump sprouts under the natural conditions which have obtained for untold centuries in the Redwood Belt. The leaves on young stump sprouts are larger than ordinary leaves and sometimes the shoot leaves recall the foliage in the top of the adult tree rather than the ordinary foliage.

Of our other naked-seeded species stump-sprouting occurs in the California Nutmeg and in the Western Yew. It is vigorous in the former but seems weak in the latter species.

Douglas Fir stumps one and a half to two feet in diameter sometimes heal over with a complete cap or callus derived from the cambium layer. The explanation of this must be that the roots are crossed with those of a living tree. I have found several such cases in the North Coast Ranges, none of them isolated. 1. Near St. Helena, stump about 3 feet high. 2. Cluster of small stumps on ridge north of Northwestern Mill at Willits. 3. John Woodhead's ranch, Jackson Valley, large stump, 5½ feet high. 4. Trail from Dyer's ranch to Hawkins Bar, Trinity County, stump 3½ feet high. 5. Three stumps, 10 to 18 inches diameter, seen on trail from Klamath River (Cottage Grove) to Crescent City. 6. Two on the west fork Illinois River, southern Oregon.

In contrast to coniferous species broad-leaved trees stump-sprout freely, although there are not a few exceptions. In this particular our arboreous oaks are interesting, the capacity to produce sprouts being very different in the two groups. Black Oaks, including the Live Oaks, are the more virile in this respect, a power only slightly weakened by age. It would, however, be difficult to grade our species according to their sprouting capacity. Black Oak sprouts

[4] Compare plate 40, fig. 2, and plate 42, fig. 2.

with great vigor, Interior Live Oak stands near it, as does the Maul Oak. Black Oak sprouts may result in circles of poles, especially in the chaparral under repeated brush fires.

White Oaks will stump-sprout when young, but several of the species lose this power completely in the adult stage, if cut off at or very near the ground. The capacity of these trees to sprout is relative to the height, increasing with the height of the stump. As an example, adult or at least mature Blue Oak trunks cut off at the ground do not sprout but may do so when cut off a few feet above the ground. Small or scrub Blue Oak cut off at the ground often sprouts vigorously. Attempts to clear land in this way only increase the scrub. Keen-witted ranchmen, therefore, girdle at the base and after the tree wastes its vitality in the crown, in one, two or three years, it dies completely.

Valley Oak offers some interesting features. It is the least virile of our oaks in vegetative reproduction. Cutting off the trunk at the ground ends the life history at once, unless it be a small or sapling-like tree. Increasing the height of the stump apparently makes no difference so long as the cut is below the first main arms or branches, but if the short stubs of the main branches be left then sprouting ensues freely. This condition may also come about, not through the agency of the axe, but through natural causes. The Valley Oak is very subject to dry rot, and trees sometimes lose the entire top except short stubs from which the crown is replaced by vigorous branches.[5] The first shoots which appear are often pendulous sprays and not erect branches, the latter being developed later. This peculiarity of producing pendulous sprays from the stubs is strongly marked in a pollarded tree where all the branches are removed simultaneously. The trunk is soon draped with hundreds of long pendulous cords as big as a quill, making a round green arbor with no suggestion of the features of the Valley Oak. The whole crown being suddenly removed, the tree meets the necessity for food assimilation in this manner: thousands of leaves are readily supported on the drooping cords which could not be displayed so promptly on erect shoots, at least not without vastly greater expenditure of wood material. A tree at St. Helena pollarded in 1901 produced cords three to seven feet long, two to three lines in diameter and with very large leaves five and one-half to seven and one-half inches long and three to five and one-half inches broad. In this connection it is worthy of note that sprouts from Black Oak stumps, the trunks having been cut squarely off at the very base, often sprawl over the ground like young grape vines, instead of producing erect shoots.

Tan Oak displays most remarkable vigor when felled, sending up several hundred sprouts about one stump, sometimes only a few, and yet again as many as fourteen hundred. The large stumps are so large and competition so aggressive that a circle of poles is ordinarily formed about felled trees. This condi-

[5] See plate 14 showing the erect new-growth main branches from the stubs.

tion also occurs in a state of nature, as is evidenced by the fact that circles of adult Tan Oak trees are not uncommon in the virgin northern woods.

Sprouts from oak stumps are remarkable for their leaf variation, especially in the way of departure from the normal type of adult foliage. Three types of leaves taken from Interior Live Oak sprouts from one stump exhibit marked differences (Fig. 2). One of these (*a*) is normal, another (*b*) similar to certain leaf-types in the hybrid Morehus Oak, one parent of which is supposed to be Interior Live Oak, while the third type recalls in its fuzziness the young leaves of the Black Oak. Coast Live Oak stump-sprouts freely and exhibits very prickly leaves.

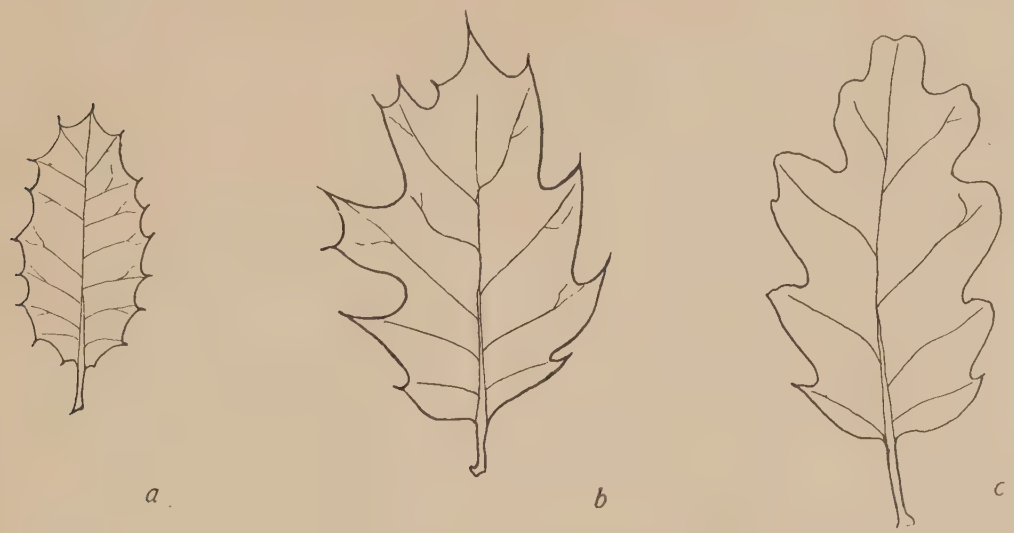


Fig. 2. Leaf-variation in *Quercus Wislizenii* DC. var. *frutescens* Engelm. (Scrub Live Oak), all the leaves taken from stump-sprouts. (Mt. San Jacinto, *H. M. Hall.*)

The stump sprouts of Maul Oak are often so vigorous and thrifty as quite to conceal the stump. While the adult foliage is notoriously variable the leaves on stump sprouts show remarkable uniformity, although they are very unlike the typical adult leaves. They are very spiny all around and very much of one size. I have found a clump of shoots covering a stump, the leaves scarcely varying in their size which was from one-half to three-quarters of an inch in length.

The willows, it need scarcely be said, sprout vigorously from the stump. Sharply pointed conical woody buds are formed in numbers beneath the bark at the base of the trunks, as for instance, in Red Willow (*Salix laevigata*).

Big-leaf Maple stump-sprouts abundantly. Old trees when overthrown by storm, fire or axe, are succeeded by stump sprouts which come up freely; this is so common a mode of natural regeneration that one often finds clumps of stems from a common base. Clusters of five or six trunks seventy-five feet

high are found along Napa River. Along the west branch of San Pablo Creek I have seen as many as thirty-eight in one cluster, the trunks twenty feet high, with an average diameter of three inches. Shoots of this size are often very glaucous. Young shoots from stumps often show interesting leaf forms. A stump ten feet long, in Mill Creek Cañon, Ukiah, bore shoots with few lobes and comparatively shallow sinuses. A few minute leaves at base of shoot were entire and not in the least cordate. (Fig. 3.) Sparingly lobed leaves may also be found on normal shoots.

Fig. 3. *Acer macrophyllum* Pursh. (Big-leaf Maple). Few-lobed or sub-entire leaves on stump-sprout shoots forced late in season by mutilation; *d*, *e*, from near the base of shoot. All figures × ½.

Oregon Ash has a similar interest. Simple or trifoliolate leaves, instead of the normal pinnately compound leaves, are frequently produced on shoots coming from stumps cut early in the season. The uppermost or embryonic scales of the bud are forced into foliaceous leaves, which forcing results in a simple blade (homologous with the terminal leaflet of the normal leaf) or in a trifoliolate leaf, in the latter case a pair of lateral leaflets having been cut off the terminal leaflet. (Fig. 4.)

Madroña trees are remarkable for the great girth of their trunks at the ground. Since they stump-sprout with great activity there is formed a large circle about the parent stump. It is one of three California species which form marked circles in the process of regeneration, the other two being the Coast Redwood and the Tan Oak, and like those two species many generations of individuals have occupied the same spot in the forest.

Two other species form circles rather rarely. Black Oak stump-sprouts vigorously but does not often form circles except in chaparral areas, where one often finds a circle of pole trees about a stump which has been excessively enlarged by repeated annual fires. California Laurel is remarkably virile in the

Fig. 4. *Fraxinus oregona* Nutt (Oregon Ash). Abnormal leaves on shoots forced from dormant or potential buds of stump by mutilation in midsummer. *a, b, c, d,* simple leaves of irregular shape; *e,* with one lateral leaflet derived from terminal leaflet; *f, g, h,* with two lateral leaflets derived from terminal leaflet. All leaves from one individual, Briceland, *W. L. J.*, no. 2205. All × ½.

A similar series was taken from one-year-old seedlings of this species in December, 1908. These seedlings developed (*a*) leaves with a single (terminal) blade, (*b*) leaves with a terminal blade as leaflet and one pair of lateral leaflets either distinct from terminal leaflet or variously conjoined with it; (*c*) leaves with a terminal leaflet and three lateral leaflets; (*d*) leaves with five leaflets.

production of new shoots along mature trunks when overthrown, or about the bases of trunks. Circles are rare, but dense clumps of sprouts are common.

Other species which stump-sprout are California Walnut (*Juglans californica*) and Blue Elderberry (*Sambucus glauca*). Mature White Alder (*Alnus rhombifolia*) does not stump-sprout so far as observed.

The phenomena connected with the girdling of trees have some scientific interest. In peeling young Tan Oak trees for the bark, one or two coils may be taken off and the tree left standing. If the tree does not die the first year, as it is likely to do if it stands exposed to the full heat of the sun, the second year

it bears a full crop—often an excessively large crop—of acorns. The woodsman calls this the "last kick" of the tree, for the third year it usually dies. Or, on the contrary, a peeled tree may continue to live for a long period, ten or fifteen years. The apparent anomaly of a tree continuing its life functions with a complete band of bark removed from its trunk is to be explained in this way. Such a tree was peeled early in the season or late in the season, when the bark did not part readily from the wood or was beginning "to stick," the result being that a very thin portion of the inner bark and cambium layer adhered to the wood, forming a sort of "scum." The scum soon presents the appearance of a thin coat of brown varnish on the wood. If one scrape it, however, the layer is seen to be greenish within and pulpy, suggesting the mesophyll layer of a leaf. A thin brown layer of this kind is characteristic of all standing peeled trees which live more than one season, but it never increases appreciably in thickness. (See the description of Tan Oak, p. 237.)

One also sometimes sees living Madroña and White Alder trees with girdled trunks. The phenomenon is somewhat similar to that of the Tan Oak. At certain seasons the outer bark comes off while the inner bark sticks.

### Seed Production.

Seed production varies according to the species and according to the year in both the broad-leaved and coniferous trees, being, as is well known, intermittent. Some species of the Coniferae bear exceedingly heavy crops of cones, notably the Yellow Pine, Tamrac Pine, and Douglas Fir, which are likewise our most aggressive species. Digger Pine and Big-cone Pine bear average crops of cones, while the Sugar Pine and Silver Pine bear cones less abundantly. The shyest bearer among the pines is the White-bark Pine, its cone deficiency being due to its exposed situation at timber line.

Most species of pines bear only one circle of cones on a given shoot of the season or in some of them the circle may even be reduced to a single cone. On the other hand, it is very noteworthy that certain of the foothill and coast pines are remarkable for the capacity to produce more than one circle of cones on the season's shoot. This group includes chiefly the closed-cone pines: the Monterey Pine produces one to three circles on a shoot of the season; the Bishop Pine produces one to five circles; and the Knob-cone Pine produces one to three circles. Multiplication not only affects the number of circles of cones in these species, but also the number of cones in a circle, which are often increased from three or five to six or seven in the Knob-cone Pine and even as many as eight in the Bishop Pine. The Digger Pine also frequently produces two circles of cones.

The Tideland (or Sitka) Spruce and the Coast Hemlock produce cones abundantly, while the Weeping Spruce and Mountain Hemlock bear by far less

heavily. The firs, compared with the pines, produce a very small number of cones. Redwood, Big Tree, and Incense Cedar have cones in abundance, although a large percentage of the seed in the two former is likely to be sterile. Cone crops in the pines and their allies fail every second or third year, this failure being mainly caused by unfavorable seasonal conditions, since all species are equally affected, although exhaustion caused by a full crop must be taken into account.

Among the oaks there is decrease in seed production every second or third year as in the case of the pines. The failure may be due to frost, or a dry year may cause a very scant crop. On the contrary a long dry period at pollination time is an important factor in the setting of the acorns. The autumn of 1908, for example, witnessed a remarkable acorn crop on the annual fruiting oaks in all parts of California. All of the species bore heavily. This phenomenon was correlated with seasonal conditions. There was practically no rain after February and none at all during the pollination period.[6]

The most abundant acorn crop comes from the Valley Oak, although doubtless the Tan Oak stands very near it in this particular. The shrub oaks of the chaparral are notably heavy bearers. Seed production in the Giant Chinquapin is lamentably weak. Madroña produces heavy crops of berries while the crown of Oregon Ash trees is usually densely filled with fruit clusters.

## Architectural Forms of Native Trees.

Every species of tree has a form which it assumes under the conditions normal to it. Coniferae from their long association in dense stands and under stress of competition for light developed one central axis with all the branches lateral to it. This architectural form, deeply impressed for countless generations, has become hereditary, so that even if grown isolated a tree will still retain this special type of architecture. Most of the species, however, instantly respond to the advantage of free space and become broad-headed. The lower limbs of Sugar Pine in open stands on San Jacinto Mountain are as long as the tree is high, while Douglas Fir may take on in certain places the broad low habit of Monterey Cypress, which is typically a broad-headed tree. (Plate 11.)

On the other hand, Monterey Cypress becomes narrow when grown in a thick forest, as do many non-coniferous trees. Tan Oak is free-branching and broad-headed when isolated, yet in coniferous forests it develops one central axis like a pine and takes on the pine habit. The broad-headed type is shown in plate 7.

Madroña in this connection offers some interesting observations. It branches widely and freely, forming a broad-headed tree. In competition for light in dense forests of Douglas Fir and Tan Oak, it is at a great disadvantage, for

[6] Jepson, Pac. Rur. Press, vol. 78, p. 309.

those species are its superiors in aggressiveness. It yields everywhere and takes what space in the forest canopy is left over; and although it usually persists and its main axis may branch not at all, yet its habit and curving tortuous trunk are far removed from all resemblance to a pine. It is only very rarely that it takes on a pine-like habit in coniferous growth. I have seen this but once, namely on the Wilder Ridge in Humboldt County.

While trees in open groves or isolated develop crowns of more or less breadth, yet there are some species which at a certain stage of growth or in certain localities develop a narrow crown, even though not crowded at all. The best example of this is the Valley Oak which is typically very broad-headed, often broader than high. Yet the pole stage of this tree is narrow-crowned although afforded free space. Young individuals may be fifteen to twenty-five feet high, three to six inches in diameter at the butt, and with short branches only two or three feet long, thus exhibiting a relatively tall and narrow column and standing quite in the open. The tree, then, begins to build the crown near where the future crown is to be and there is in consequence little waste of branches. In the Blue Oak the crown starts nearer the ground and gradually moves upward.

The Digger Pine is a species forming an open stand. While in its typical form it branches freely and becomes more or less broad-headed, in certain localities its main axis does not branch or but rarely. I have seen many trees on the upper San Benito River with crowns as narrow as those of a White Fir in the dense forest of the Sierra Nevada and eighty to one hundred and ten feet high. Yet these trees were separated by intervals of several hundred yards and formed a stand without other growth save chaparral. In this case, as in that of the Valley Oak pole trees, there is a definite polarity which shapes the tree regardless of the immediate environment.

The phenomenon of two-ranked branching from the main trunk, or arrangement of the primary branches in one plane, attracts the attention of the traveler in restricted areas or districts. In Tehama County I observed in 1899 a remarkable number of two-ranked Digger Pine and Blue Oak trees in the Cottonwood Creek district.

The most pronounced variations from the usual form of a tree are those departures found in the chaparral. The chaparral is a shrub area, consisting not of a single species but of many species belonging to many different families which have assumed a common habit in response to the hard conditions of their growth. They are characterized by their rigid stems, often bearing thorn-like branchlets, and small, thick or leathery leaves, in some cases, as in the Manzanitas, placed vertically to escape the direct rays of the sun. In addition to these genuine chaparral shrubs, certain trees recur in the chaparral in shrub form. The following are to be noted:

| Tree Form. | Chaparral or Shrub Form. |
|---|---|
| Cupressus macrocarpa Hartw. (Monterey Cypress). | C. Sargentii Jepson. |
| Quercus lobata Neé (Valley Oak). | Dwarf form. |
| Quercus Garryana Dougl. (Oregon Oak). | Var. Breweri Jepson and var. semota Jepson. |
| Quercus chrysolepis Liebm. (Maul Oak). | Forma nana Jepson. |
| Quercus agrifolia Neé (Coast Live Oak). | Var. frutescens Englem. |
| Quercus Wislizenii DC. (Interior Live Oak). | Var. frutescens Englem. |
| Quercus Kelloggii Newb. (Black Oak). | Forma cibata Jepson. |
| Pasania densiflora Oerst. (Tan Oak). | Var. echinoides Sarg. |
| Castanopsis chrysophylla A.DC. (Giant Chinquapin). | Var. minor Benth. and C. sempervirens Dudley. |
| Umbellularia californica Nutt. (California Laurel). | Chaparral form. |

The dwarf form of the Valley Oak is seldom observed but is sometimes seen on the edge of chaparral. Var. *semota* of the Oregon Oak is abundant in the southern Sierras, and var. *Breweri* on Marble Mountain and the Siskiyous. Forma *nana* of the Maul Oak is a low shrub of minor importance in the chaparral. Var. *frutescens* of the Interior Live Oak has exceedingly tough and rigid stems with small spiny leaves. It is in its habit remarkably unlike the great round balls typical of the species on the plains of the Sacramento. Var. *frutescens* of the Coast Live Oak is the low scrub of the hill summits with markedly spiny leaves. Forma *cibata* is the low form of the Black Oak on the high ridges in the inner North Coast Range from Snow Mountain to the Yollo Bollys. It is a browse shrub for range cattle in that region. Var. *echinoides* of the Tan Oak forms extensive colonies in southwestern Oregon and adjacent California, eastward to the region about Mt. Shasta, extending into the northern Sierras. It has been developed from ordinary Tan Oak by many times repeated fire devastation of ridges. The chaparral form of the California Laurel, a slender pointed shrub, is not infrequent in Coast Range chaparral. Further notice of the above forms may be found under the descriptions of the species. The shrub form of the Scrub Oak (*Quercus dumosa*) is its normal form. In all of these cases the strongest modifying force is the lack of water, which is, however, second only to the factor of dry season temperature which ranges high.

Another variation in form is in some cases correlated with longitudinal range in California. There are not a few species which exhibit a disposition to produce larger individuals towards the southern limits of their range. Islay (*Prunus ilicifolia*), a shrub of the South Coast Ranges, is not infrequently arborescent in Southern California. *Prunus emarginata,* a bushy shrub of the Sierra Nevada and Coast Ranges, is distinctly arborescent in Southern California, a condition repeated on the eastern slope of the Sierra Nevada, as along the

Truckee River (*Mrs. K. Brandegee*). Flannel Bush (*Fremontia californica*) is a diffuse though tall shrub in the Sierra Nevada; near Cajon Pass, in Southern California it assumes a far more arboreous habit, becoming apple-tree like, although not always with a single stem (*H. M. Hall*). This state doubtless occurs elsewhere in Southern California.

### Wind-controlled Tree Forms.

The effect of wind in modifying the normal form of trees varies with the species, the locality, soil and its water content, and amount of wind. The most abundant examples of wind-blown trees are to be found in the Sierra Nevada near timber line or along the sea coast. In the Sierra the most striking effect of wind is one of excessive desiccation which results in killing out the branches or main axes, followed by the dismantling of the tree by the mechanical force of the winds. Sierra Juniper and Foxtail Pine (Plate 19) are examples. Sometimes the crown of a conifer, as in Tamrac Pine, becomes one-sided as if bisected, through the windward branches being mechanically massed to leeward.[7] On the coast the same forces are at work, but desiccation is less extreme, with the result that moulded crowns are more frequent than dismantled crowns.

During the late spring and summer, winds from the Pacific Ocean blow up the Sacramento Valley from the southwest and up the San Joaquin Valley from the northwest. They are the prevailing winds and often become, by steady increase, high winds. The direction of these air-currents is sometimes indicated in the one-sided crowns of Valley Oak and Coast Live Oak trees. In particular channels or openings in the Coast Range hills, where the winds are severe, the trunks frequently become nearly horizontal with the crowns bent along the ground. The tender shoots are carried out horizontally in the growing season and, on account of the even velocity of the wind, held in position with remarkable steadiness until they lignify. While the shape of the tree is governed partly by the desiccating influence of the wind, the effect of temperature is an influence not negligible. Shoots on the windward side grow but slightly and on the leeward side show a strong growth, chiefly because of excessive transpiration on the windward side, but also because the temperature on the leeward side of the tree is higher than on the windward side. This difference in temperature when the trades are blowing is very marked on the two sides of a wall which stands at right angles to the direction of the wind. (Plate 9.)

The soil is also a factor in determining ability of trees to maintain well-balanced crowns in the face of heavy gales. Valley Oaks growing in the richest loams are unaffected or only slightly moulded by the winds which disturb the symmetry of trees of the same species standing in adobe or clay soil, but which are subject otherwise to exactly equal conditions.

[7] This condition is excellently illustrated in plate 8.

In connection with the moulding of the crown of the tree, there is a certain retardation of growth. Wind-controlled trees are generally more or less dwarfed but such dwarfing is usually due chiefly to poor soil or lack of water. On the Monterey sand-hills between Del Monte and Pajaro grow tens of thousands of Coast Live Oak trees like roundish balls, only four to seven feet high, many of them little larger than the largest of the Bush Lupines growing with them on the heath-like undulations. The thin sandy soil is almost wholly responsible, in our view, for the dwarfing, although most of the trees are wind-controlled. The effect of the wind is chiefly to be seen in the moulded crowns.

No other California tree responds so easily to moulding by the winds as the California Laurel, although it is only near the coast that wind-shaped forms are seen (Plate 10). Colonies of sapling-like trees in cañons have their tops shorn to an even surface remarkable for its lawn-like smoothness. Such colonies vary in height according to the locality or configuration of the cañon or hill. The velocity of the wind increases from the ground upwards. At a certain height the velocity prohibits further upward growth because, through increasing transpiration, its power is desiccating. Bushes growing at the leeward summit of a hill are cut off by the wind in such a way as to prolong the line of the windward side of the hill over the leeward side.

On the California coast no tree shows such picturesque relation to wind forces as the Monterey Cypress. (Plate 11.) The effect of the wind upon the form of the crown is largely mechanical. Young trees are symmetrical, old trees exceedingly unsymmetrical or broken, even when of the same height and standing side by side near the shore. The most striking structures of the wind-broken trees are the board-like trunks or branches which are only six to nine inches thick, but become one to nine feet broad. To what extent these buttressing structures are due to the load of the crown or branch and to what extent to wind-strain, if any, is to be determined, but so far as observed by the writer they are associated with, although not peculiar to, all of the wind-controlled trees of the shore line. Such structures have not been observed on protected trees back of the shore line nor on trees in cultivation. Another characteristic feature is that the old wind-broken trees develop an exceedingly thick weave of branchlets and foliage, forming dense masses which are in marked contrast to the open habit of the tree as seen in youth.

These general observations apply to trees standing near the shore which are subject to the severest possible attack by wind; a short distance from the shore, even one hundred yards away, they are perfectly symmetrical. On account of the complete shelter it affords no other tree is so much planted along the coast for windbreak. At stations where extreme moulding of California Laurel takes place this tree shows no effect of wind whatsoever. So it may safely be said that no other coast tree resists wind action so well. (Cf. descrip-

tion of Monterey Cypress.) In situations where the wind currents are at times of very high velocity I have seen in cultivated plantations the tips of finger-pointed branchlets crooked, fish-hook like, by the mechanical stress of the gale. I have also observed the summit of the axis one-sided, on account of the branchlets being mechanically forced to leeward.

Redwood is sometimes a wind-controlled beach tree. (Plate 12.) Bishop Pine, another strictly beach tree, is excessively wind-torn wherever it stands alone. The forces at work in this case are almost wholly mechanical (Plate 13).

In relation to the mechanical force of winds, records of wind velocities are of significance and interest. Records of wind velocities are, however, available from comparatively few stations in California. The extreme wind velocities per hour on the coast as found in the records are as follows: San Francisco, 60 miles; Point Reyes, 120 miles; Cape Mendocino, 144 miles; Eureka, 50 miles (U. S. Monthly Weather Review, vol. 31, pp. 65, 226). All the above records of high winds were of southeast winds. Southeast winds are specially referred to below.

Of all the winds on the coast the westerly or trade winds, as has been indicated, are of chiefest importance in relation to wind-controlled trees. The pressure of the trades against the land is so great that they break through the openings in the Coast Ranges, especially at or near the Golden Gate, and flow like so much water towards the great interior valley, being deflected north along the Sacramento and south along the San Joaquin. A record of winds at Point Reyes in excess of fifty miles per hour for one year is given in the subjoined table. All the winds marked "NW" and "SW" are trade winds and pass over the stations illustrated in plates 9, 10, and 13. The table is compiled from U. S. Weather Bureau records, and indicates the number of days in each month on which high winds occurred and the velocity.

It will at once be seen that the prevailing high winds are northwest, that high winds occurred from that quarter in every month in the years in question and that they occurred with greater frequency in April, May, June, and July than in any other three or four months. The period of greatest frequency is also the period of active tree growth, and the effect of these winds on California Laurel and Coast Live Oak stands is very marked in many places in the Marin County district (Plate 10).

Southeast winds occur in middle California mainly during the wet season. They blow with great violence but only for short periods of generally one-half to two days and do not occur frequently. They are usually associated with heavy precipitation. The available data seem to show that they are of higher velocity than any other winds, there being records of sixty miles per hour at San Francisco, one hundred and twenty miles at Point Reyes, sixty miles at Sacramento, thirty-eight miles at Fresno, and forty-two miles at Red Bluff.

MAXIMUM WIND VELOCITIES AT POINT REYES.

| | 1906 | | 1907 | | | 1906 | | 1907 | |
|---|---|---|---|---|---|---|---|---|---|
| Month | Velocity | Direction | Velocity | Direction | Month | Velocity | Direction | Velocity | Direction |
| January | 59 | S | 60 | NW | June | 54 | NW | 58 | NW |
| | 67 | SW | 64 | S | | 51 | NW | 67 | NW |
| | 57 | SW | 50 | NW | | 50 | NW | 52 | NW |
| | 53 | SW | 52 | NW | | 67 | NW | 50 | NW |
| | 74 | S | 58 | S | | 56 | NW | 53 | NW |
| | 51 | SW | 52 | NW | | 53 | NW | 84 | NW |
| | 70 | S | 66 | SW | | 52 | NW | 52 | NW |
| | 61 | NW | | | July | 57 | NW | 53 | NW |
| February | 60 | SW | 56 | NW | | 50 | NW | 50 | NW |
| | 70 | S | 52 | NW | | 56 | NW | 59 | NW |
| | 55 | S | | | August | 60 | NW | 56 | NW |
| | 56 | NW | | | September | 50 | NW | 60 | NW |
| | 62 | NW | | | | 57 | NW | 56 | NW |
| March | 55 | NW | 72 | S | | 74 | NW | 51 | NW |
| | 61 | S | 60 | SW | | 58 | NW | 50 | NW |
| | 68 | S | 59 | NW | | 65 | NW | 60 | NW |
| | 62 | S | 52 | NW | October | 50 | NW | 72 | NW |
| | 61 | S | 57 | S | | 50 | NW | 74 | NW |
| | 50 | NW | 55 | S | | 66 | NW | 78 | NW |
| | 57 | S | 54 | S | | 62 | NW | 52 | N |
| | 63 | S | 82 | S | | 70 | NW | | |
| | 50 | S | 84 | S | | 71 | NW | | |
| | 70 | NW | 62 | SW | | 50 | N | | |
| | 74 | NW | 53 | NW | November | 57 | S | 64 | NW |
| | | | 52 | NW | | 60 | S | 70 | NW |
| April | 68 | NW | 54 | NW | | 60 | NW | 69 | NW |
| | 74 | NW | 54 | NW | | 76 | NW | 50 | NW |
| | 62 | NW | 56 | NW | | 58 | NW | 52 | S |
| | 56 | NW | 62 | NW | December | 92 | S | 72 | S |
| | 53 | NW | 51 | NW | | 80 | SW | 66 | S |
| | 71 | NW | 62 | NW | | 82 | NW | 58 | S |
| | 71 | NW | | | | 62 | NW | 52 | SE |
| May | 54 | NW | 55 | NW | | 54 | NE | 82 | NW |
| | 52 | NW | 84 | NW | | | | 72 | S |
| | 50 | NW | 50 | NW | | | | 70 | S |
| | 56 | NW | 50 | NW | | | | | |
| | 61 | NW | 50 | NW | | | | | |
| | 65 | NW | 52 | NW | | | | | |
| | 68 | NW | | | | | | | |
| | 56 | NW | | | | | | | |
| | 54 | S | | | | | | | |

Nevertheless, they are of no significance in moulding tree forms, save in the occasional overthrowing or branch mutilation of an individual, or in relieving the tree of dead weight. On the occasion of heavy rainstorms in early winter these winds effectively clear the crowns of oaks and other trees of dead branches and twigs. The floor of a Redwood forest after such a gale is often found littered with debris,—from mere twigs to dead limbs out of the tops weighing one-fourth to one ton each. The significance of this litter in relation to seedling reproduction is referred to in the description of *Sequoia sempervirens.*

The north winds blow down the Great Valley ten to fifteen times a year, usually three, rarely one, two or four days at a time, but do not shape tree forms. While they blow with great violence they are exceedingly fluctuating in their velocity. What is more significant, they are cold and dry in winter and hot and dry in summer, and always check vegetation.

### Weeping Trees in California.

Long pendulous branchlets give to two California trees a marked habit. The Weeping Spruce with its stiff horizontal arms and pendulous branchlets is singularly different from any other conifer. It is thus well protected by its peculiar and very thin crown from the effects of heavy snowfall and winter storm which often work great damage to other trees in the high North Coast Ranges.

The Valley Oak has slender branchlets five to twenty feet long, which hang from the ends of the branches about its great crown and attain their most striking development on trees standing a little apart from each other on the richest and moistest valley loams (Plate 14). On crowded trees the branchlets are in general produced only on the free sides of the crown, while poorly nourished trees of the clay hills do not develop them at all or very feebly.

The two species above mentioned are our only trees which normally produce pendulous cords of considerable length. Weeping branchlets in other species occur for the most part exceptionally, being due to sporting of individuals, to changed light conditions in the forest, to disturbed nutrition or pathological causes. The observed cases are few, but the record of them may stimulate further observation.

Open stands of Coast Live Oak in the valleys often show some trees which exhibit a disposition to develop pendulous sprays. This is to be observed in the Gilroy Valley and elsewhere.

Pendulous branchlets are sometimes produced as a result of effort to secure new light space below the crown arising from changes in the forest. Tan Oak under such conditions may occasionally develop weeping sprays. On the other hand Maul Oak standing in the open sometimes exhibits a markedly weeping form.

Short pendent branchlets are rather characteristic of the Douglas Fir. Occasionally it shows cord-like branchlets five to eight feet long, especially on the lower part of the tree when it has become less crowded in age through the death of surrounding individuals. Witch-broom trees of this species may produce cord-like branchlets in great profusion. On the Miamber Trail between Scott Bar and Scott Valley, Siskiyou County, grows a Douglas Fir witch-broom tree. The trunk is affected at eleven feet from the ground. The abnormal growth about the trunk in conjunction with the pendulous branchlets forms a dense arbor nine to eleven feet in diameter. When passing this tree in 1907 I turned my riding animal out of the mule train and rode into the arbor and around the trunk. The cord-like branchlets, four to eight feet long, were in this case evidently associated with disturbed nutrition, caused in all probability by the activity in the trunk of an exoascus or similar species of ascomycetous fungus.

A few other conifers may be added to the list. Canoe Cedar normally produces pendent branchlets about one foot long. Tideland Spruce is in somewhat similar case, but certain individuals are, like the Douglas Fir, far more striking in this particular.

Of our species of pines I have but a single instance. While a number of pines bear strikingly declined branches and branchlets, as in the case of the Yellow Pine, these do not answer to pendulous branchlets within the meaning of the present section. G. K. Gilbert, of the United States Geological Survey, tells me that he observed a weeping Tamrac Pine tree in the Sierra Nevada at Blaney Meadows, on the south fork of the San Joaquin, in 1908. The tree was apparently normal otherwise. Another tree as markedly weeping on the lower part of the crown, changed abruptly to normal in the top of the tree.

Occasional Redwood trees are remarkable for the declined or drooping branches which clothe the main axis throughout, but these cases are not comparable with the types first mentioned.

Other species which normally or occasionally produce drooping sprays are the Aspen, California Laurel, and Port Orford Cedar.

### Nanism in Endemic Species.

When the reproductive stage occurs at a very early age the tree often simulates a dwarf. Such a condition is called nanism, a term which covers all cases of generative maturity in juveniles. The most striking case of nanism in California trees is that of Dwarf Cypress as it occurs on the Mendocino "White Plains," extending from Fort Bragg to Mendocino City. We have here a low level plateau, lying about a mile back of the ocean shore and about 100 feet above sea-level. The soil is highly charged with alkaline salts, appearing white in some places, black in others, and it forms a thin coat over a sandstone bedrock

only six inches to two feet below the surface in most places. The Dwarf Cypress grows very thickly in certain areas and has developed in miniature. In its smallest form it consists of a slender axis without branches and few short branchlets. Such juveniles fruit at a very early age, when only one or two feet high and six to eight years old. Other conifers behave similarly on this area. Beach Pine develops in dwarf form, fruiting when only three or four feet high, and six to nine years of age. Bishop Pine grows only eight to twenty feet high, but produces cones in abundance. The Giant Chinquapin also grows here as a shrub six to twelve feet high, and bears an abundance of burs.

Another notable case of nanism is that of the Knob-cone Pine, which fruits at six to nine years of age. Such dwarfs, mere slender canes two to five feet high, stand on gravelly or rocky hill-slopes of great aridity. The life-history of this species simply shows an adaptation to repeated brush fire. If the generative cycle were longer and absolutely fixed then the species would probably become extinct. Manzanita (*Arctostaphylos manzanita*) is in similar case and sometimes fruits very early.

Yellow Pine rarely shows nanism, but I have seen trees bearing cones in the juvenile period, that is, when only five to six feet high. The variety *minima* Lemm. of the Silver Pine also bears cones at a very early age. (Lemmon, 2d Rep. Cal. Board For., pp. 70, 80, 1888.) Nanism is, therefore, not synonymous with dwarfing, since true dwarfs arrive at the normal age before reproducing or do not fruit at all.

In all the above cases the reproductive phase has been accelerated by dryness, fire, or disturbed nutrition. The chaparral forms of trees listed above have some interest in this connection. Var. *frutescens* of the Interior Live Oak and var. *echinoides* of the Tan Oak bear at seemingly early age astonishingly heavy crops of acorns or drupes. Such shrubs, however, may not be as young as they seem and further investigation along this line is needed since stems in the fire area of the chaparral mainly come from old root crowns.

## Natural Hybrids.

*Quercus Morehus*[8] is a name given by Dr. Albert Kellogg to a singular tree which has until later years been little known. While there is by no means consensus of opinion it is generally regarded as a form of hybrid origin, one parent being the Black Oak and the other the Interior Live Oak. In support of this opinion it may be said (1) that the individuals seem intermediate between the two species named, (2) that they are variable in character, (3) that some of these variable forms show other hybrid characteristics in that they recall in certain features what are probably remote ancestors instead of their immediate

[8] *Quercus Morehus* Kellogg, Proc. Cal. Acad., vol. 2, p. 36 (1863); Greene, West Am. Oaks, pp. 3, 47, 79, pl. 2 (1889); Sargent, Silva N. Am. vol. 8, p. 120 (1895); Sudworth, 21st Rep. U. S. Geol. Surv., pt. 5 (For. Res.), p. 519 (1900).

parents, (4) that the number of individuals is few, (5) that the range is discontinuous, and (6) that they are eccentric in production of acorns. *Quercus Morehus* has, however, not even yet received that special and thorough study which its interesting character deserves, and some of the points stated may lose in weight on further investigation. It occurs at scattered points in the Sierra Nevada, in the Berkeley Hills, on Mt. Tamalpais, on the Van Arsdale Ranch at Ridgewood in Mendocino County, but is most common in the Mt. St. Helena Range from Twin Sisters Peak northward to the region of the Ukiah-Blue Lakes grade. A very considerable number of trees occur on the eastern slopes of Twin Sisters Peak in western Solano County from near the valley level to 1800 feet altitude, and these in their foliage show every gradation between the Interior Live Oak and the Black Oak (Fig. 5). Some of these trees, however, are clothed with leaves which, while in a formal sense intermediate in character between the species named, are so suggestive of the leaves of a genus closely allied to the oaks that these particular trees were constantly spoken of in the field as "chestnut trees" at the time of the field examination. There were no acorns on any of these trees in the autumn of 1903[9] and it is thought that this form as a rule fruits sparingly, but Carl Purdy, who holds views contrary to the author as to its specific character, says that certain trees near Ukiah, long familiar to him, fruit most freely. In studying the fruit it will be most interesting to remember that the acorns of the two assumed parents are very dissimilar in structure. In the Sierra Nevada of Calaveras County it is called Evergreen Black Oak, since it holds its leaves like those of the Live Oak until the new leaves come in the spring. In El Dorado County it is termed Spanish Oak by the settlers, who value its wood above that of either parent.

A Morehus Oak stands at the northerly end of Lagoon Valley, Solano County. R. H. Platt, who has observed this tree for several years, says the acorns "usually blight in the cup," but the tree bore fruit in the fall of 1903 (Fig. 5).

Since the above was written I have had the following note from the Kaweah region, written by Ralph Hopping: "There are three *Quercus Morehus* trees at the head of Sheep Creek. One is seven feet in circumference and had a good crop of acorns in 1907. A few feet from this tree stand both *Q. Kelloggii* and *Q. Wislizenii,* and the characteristics of both are wonderfully blended in the hybrid. The foliage, while having the sharp stiff leaves of *Q. Wislizenii* (only larger) retain the hair at the end of the lobe as in *Q. Kelloggii.* The acorn cup

[9] On October 3, 1908, the writer revisited the locality and collected acorns from two typical Morehus Oak trees. Most of the Morehus Oak trees appeared to be sterile. A tree with the "chestnut type" of foliage stands two hundred yards north of the wagon grade in a swale about one mile from the entrance gate to the Twin Sisters water reservation at the valley level. The ground beneath this tree was covered with half-grown dropped acorns. Numerous *Quercus Wislizenii* trees were fruiting freely, nearly every one examined having its own peculiar type of acorn and foliage. Many of them were especially interesting as showing indications of being secondary or tertiary hybrids between *Quercus Wislizenii* and *Quercus Morehus.* A few trees of *Quercus agrifolia* were observed on the mountain; their acorns were evidently ripening later than those of *Quercus Wislizenii.*

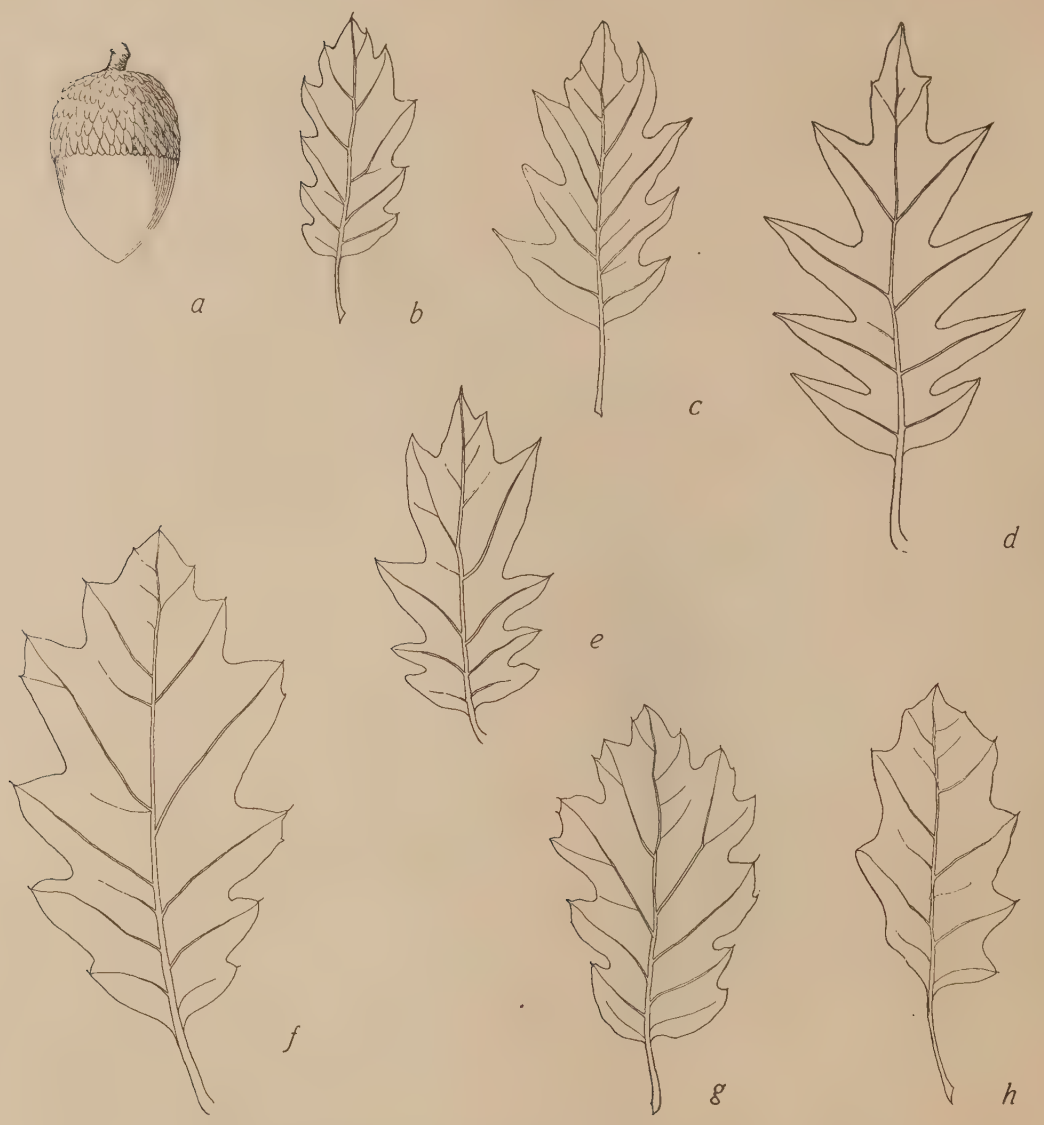


Fig. 5. *Quercus Morehus* Kellogg. *a, b,* acorn and leaf of tree in Lagoon Valley, *R. H. Platt. c, d, e, f, g, h,* series of leaves, showing variation from *Quercus Wislizenii* to *Quercus Kelloggii.* Twin Sisters Peak, *W. L. J.,* nos. 2381, 2379, 2386, 2377, 2375, 2377, respectively. *a* = natural size; *b-h* = × ½.

is a blend between the two and about midway in size as in the acorn, which has the *Kelloggii* pubescence and in some cases the stripe of the Live Oak acorn. The trunk is very much like the Black Oak."

Specimens from an undoubted *Quercus Morehus* tree at West Point, Calaveras County, have been sent me recently by Mrs. Augusta D. Reid, who says the acorns ripen in advance of any other oak. The cups are deep-cupped as in *Quercus Wislizenii;* the nuts are cylindric, ten to twelve lines long, six lines in diameter, and blunt at tip, thus suggestive of *Quercus Kelloggii.* Another hybrid tree, or rather cluster of six sprouts from an old stump, grows near Sebastopol. Acorns have never been produced according to Mrs. Charles L. Wheeler, who has had the cluster under observation.

The MacDonald Oak (*Quercus MacDonaldii* Greene, West Am. Oaks, pp. 25, 73, t. 34) is a tree or shrub fifteen to thirty-five feet high. Typically the leaves are two to two and one-half inches long, oblong but broader above the middle, the upper portion sinuate-lobed, the lower portion entire. It was first found on Santa Cruz Island, and is said to be on Santa Catalina. Specimens from Los Angeles County have been determined by the author of the species as *Quercus MacDonaldii.* By reason of its intermediate characters and rarity it is probable that it is a hybrid between *Quercus dumosa* and *Q. Engelmanii.* In further support of this view it may be indicated that *Quercus MacDonaldii* var. *elegantula* Greene, which grows at Fallbrook, was subsequent to its publication, decided by Greene (West Am. Oaks, p. 63) to be a hybrid of *Quercus dumosa* and *Quercus Engelmanii.*

Willows frequently hybridize in a state of nature. In all regions where the native willows have been carefully studied the occurrence of hybrid trees has been noted. With us but one hybrid willow has been thus far put on record. Mott has studied in detail a tree at West Berkeley which he determined to be a hybrid between the indigenous Yellow Willow, *Salix lasiandra,* and the exotic Weeping Willow, *Salix babylonica* (Univ. Calif. Publ. Bot., vol. 2, p. 196). Anderson had previously made record (Zoe, vol. 1, p. 41) of a monoecious willow at Santa Cruz that he believes to be a hybrid between Yellow Willow and Weeping Willow.

Natural hybrids of the native California Walnut and the eastern Black Walnut (*Juglans nigra* L.) occur where the two trees are planted together in streets or groves, and both of these species in like manner spontaneously hybridize with the English Walnut (*Juglans regia* L.) according to E. J. Wickson and other horticulturists.

Carl Purdy tells me that on Red Mountain in southeastern Mendocino County there is an area of Sargent Cypress and an area of McNab Cypress. In the intermediate area occur numerous individuals, which in all their features indicate a hybrid origin from the above parents.

## The "Walnut-Oak Hybrids."

Ernest B. Babcock.

On E. S. Ware's ranch in Garden Grove, Orange County, there stand, where first transplanted from seed bed to nursery row, two seedling trees that are now (April, 1908) seven years old. Their height is about twenty feet, extreme spread of branches of a single tree fifteen feet and circumference of trunk six inches above ground twenty-three and one-half inches. These trees were propagated by D. C. Disher, who states that because of their striking characteristics they have received the same attention as did the walnut orchard into which the nursery was changed after the marketable trees were removed.

In the fall of 1900 Mr. Disher gathered nuts from a certain tree of *Juglans californica* Wats., that grew near Yorba, Santa Ana Cañon, but which has since been destroyed. These nuts were planted in the spring of 1901 in order to raise seedlings upon which to bud the English walnut for commercial purposes. Out of some two thousand seedlings, about twenty appeared from the first to be distinct from *Juglans californica.* Of all these only the two above mentioned remain where they originated, one being fertile and the other sterile. The one which is fertile will be referred to hereafter as the original fertile tree. Most of the others were given away; one, destroyed because of its weak growth, had, according to Disher, simple leaves exclusively. The writer has seen seven of the distributed trees and in leaf and bark characters as well as in general appearance they closely resemble the original fertile tree. Three of these seven are growing near the experimental garden of N. B. Pierce of Santa Ana and one of the three bore a full crop of nuts in 1907.

Perhaps the most interesting thing about these trees is the fact that they possess some qualities which suggest oak trees. When in full leaf, if viewed from a little distance, the mass effect of the foliage certainly resembles that of a small-leaved oak more than that of a walnut. Certain leaf characters are also strongly suggestive. These features, together with the fact that the parent tree stood close beside a Coast Live Oak tree, according to Disher, are sufficient to explain the origin of the local name, "Walnut-Oak Hybrids."

The question of the behavior of second and third generations is not clearly answered. In second generation seedlings, the distinctive leaf characters are constant in each individual; that is, so far as observed there is never a mixture of leaves typical of the anomalous form and leaves typical of *Juglans californica.* But, among the seedlings, there appears to be a more or less extensive "reversion" to the *Juglans californica* type of leaf. The largest number of second generation seedlings the writer has yet seen were grown by N. B. Pierce. In February, 1908, he planted all the nuts taken from his bearing

*a* *b*

Fig. 6. The two original specimens of "walnut-oak hybrids" on the E. S. Ware ranch at Garden Grove, California; *a*, the fertile tree; *b*, the sterile tree.

tree the preceding fall and when seen late in March there were about one hundred seedlings with two or three leaves. Of these it appeared that considerably over half, perhaps even three-fourths, bore leaves like those of *Juglans californica.* Mr. Disher also has second-generation trees, two in number, four years old which resemble their parents closely. He also propagated two second-generation trees now one year old which are growing in the botanic garden of

Fig. 7. A series showing some variations in the leaves of "walnut-oak hybrid"; *a, b, c,* from original fertile tree; *d,* from another first-generation specimen that appeared in 1905; *e, f, g, h,* four nuts from original fertile tree.

the University of California. Unfortunately he kept no record of the number of seedlings that appeared with leaves typical of *Juglans californica.* A large proportion of the seeds always fail to germinate.

As a matter of fact, just what these trees are, remains to be demonstrated and further study on the nature of their origin and relationships is highly desirable. The hypothesis of origin through hybridization between *oak* and

*walnut* is suggested by the local name. From my observations and experiments, it certainly appears that this hypothesis is not the only probable one.

For purposes of reference, I append a description of the original fertile tree, which is shown on the left in figure 6. The description is based upon material gathered in the fall of 1907 and spring of 1908. This material is deposited in the herbarium of the University of California.

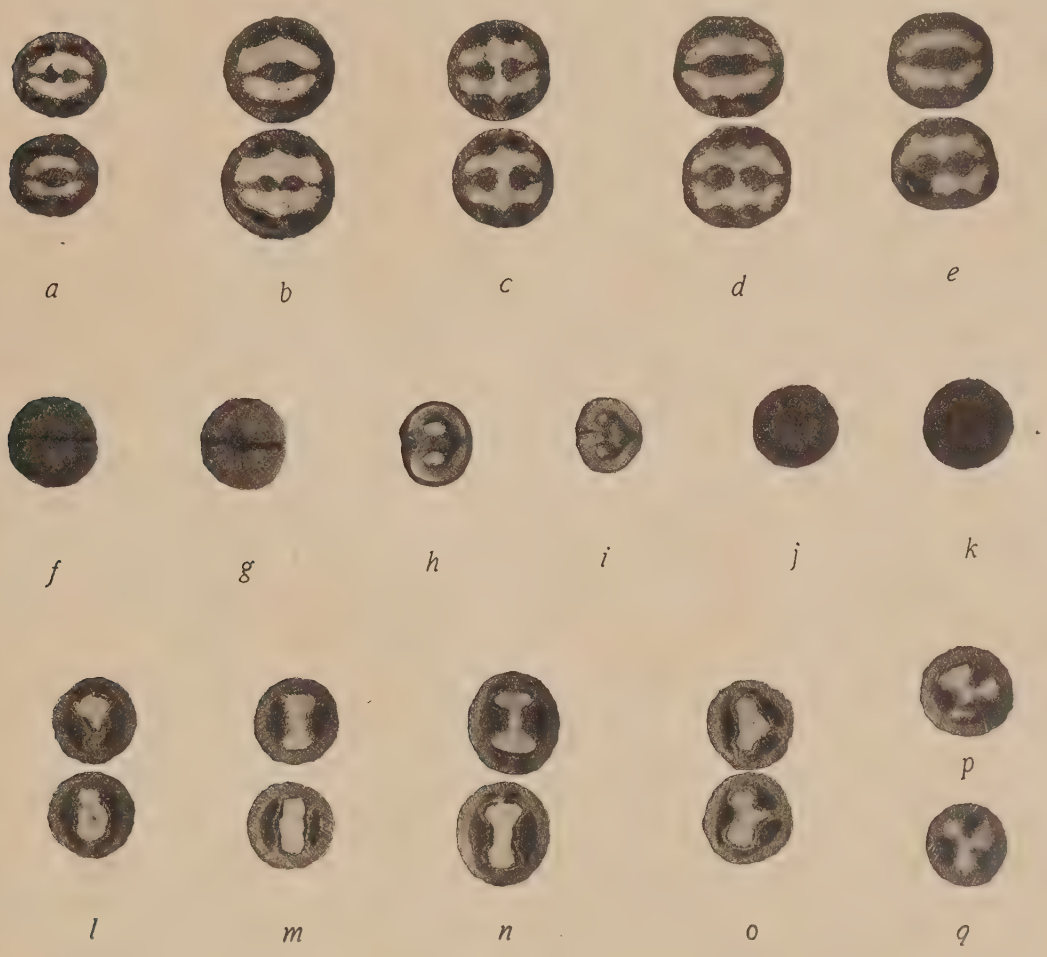


Fig. 8. *a, b, c, d, e,* five nuts of *Juglans Californica* sectioned transversely; *f, g, h,* three nuts from *Juglans Californica; i, j, k;* three nuts from original fertile tree; *l, m, n, o,* four nuts from original fertile tree sectioned transversely; *p, q,* transverse sections of two nuts from original fertile tree.

### Description of Original Fertile Tree.

Tree 20 feet or more high. Bark aromatic and strongly walnut-scented. Branchlets hollow-chambered with pithy plates. Twigs, bud-scales and young leaves granular-pubescent. Buds few-scaled, axillary or superposed. Leaves 1 to 3 inches long, alternate, exstipulate, mostly compound with three leaflets; terminal leaflet two or three times as long as lateral leaflets and ranging from ½ to 2 inches in length, in form varying from broadly ovate through oval to elliptical or oblong, truncate or emarginate at the apex, margin serrate or almost entire; lateral leaflets opposite or scattered, with petiolules or sessile, sometimes one or both lacking; petiole equal to, shorter or longer than the terminal leaflet. (Fig. 7, a, b, c.) Flowers monoecious, apetalous. Staminate flowers in lateral catkins from wood of the preceding year; calyx adnate to the inconspicuous dark red bract, irregular, consisting of three larger and 1 or 2 smaller lobes and an inner whorl of 4 to 6 smaller distinct sepals, one or two of which sometimes show stamen characters; stamens sepaloid, 10 to 13, with 1 to 4 of the central ones abortive; filaments free, very short; anthers variable, the pollen sacs unequal especially in the outermost stamens, connective not bifid at the top. Pistillate catkins 3 to 6-flowered, terminating branchlets of the same season's growth; calyx irregularly 4 to 7-lobed, adherent to the inferior 1-celled ovary; the latter often with 1 or 2 longitudinal grooves or ridges, rarely with 2 or 3 fleshy bracts near the base; styles 3 or 4, short, united toward the base or free, stigmatic along the inside, the fringed surfaces forming a rosette. Fruit similar in appearance to that of *Juglans californica* Wats., but smaller and more variable as to form and internal structure of the nut; the seed also much smaller; cotyledons much reduced, not convoluted. (Figs. 6, 7, 8.)—E. B. B.

### Teratology in California Trees.

Comparatively few cases of teratology in our native trees have been observed, or at least recorded. This is a brief list of observed cases, abnormalities which are plainly pathological being excluded.

In the Redwood (*Sequoia sempervirens*) prolification of the cone in a vegetative shoot has been observed by the author in material from Redwood Peak, Alameda County. A cone of Douglas Fir having the seed-bearing scales subtended by slightly modified leaves has been discovered and discussed by Lloyd (Bull. Torr. Club, vol. 25, p. 90). Abnormal leaves resulting from hypertrophy of scales and induced on staminate shoots of *Pinus ponderosa* by pruning have been described by Lloyd (Ann. N. Y. Acad. Sci., vol. 11, p. 45). "White Redwood" is a term applied to the etiolated shoots of *Sequoia sempervirens* found in deep shades and always near the base of the tree. They have been found on

Big River, in the Santa Cruz Mountains and on the Sur Coast, and doubtless in several other places. This condition of albinism has been discussed by Peirce (Proc. Cal. Acad., ser. 3, Bot., vol. 2, p. 83). Fasciation of stump sprouts in Redwood has also been observed a number of times. A fasciated branchlet one-half inch wide was collected by the author in San Leandro Cañon, near Moraga Ridge, in Contra Costa County. In September, 1909, I received from Pescadero a remarkable example. The stem below, one and one-fourth by three-fourths inches in diameter, suddenly expands into a fasciation six and one-fourth inches wide and about one-fourth line thick except on the two edges which are rounded and one-fourth inch thick. This thin structure is eight inches long and surmounted by a great irregular crest or mane of shoots of every length up to twelve inches long and varying in character from ribbons one and one-half inches wide to normal shoots. Inquiry elicited the fact that this shoot came from the stump of a logged tree. Bisexual catkins of weeping Spruce (*Picea Breweriana*) were collected by the writer in the top of a tree near Marble Mountain. These catkins were one inch long, the upper half ovulate with dark purple scales, the lower half yellow-brown and staminate. Bisexual catkins have been observed several times on Arroyo Willow at Berkeley.

A tree of Coast Live Oak (*Quercus agrifolia*) at Berkeley produced acorns with two or three seeds in 1901. Similar developments are noticed in California Buckeye (*Aesculus californica*), where the pod not infrequently develops two seeds. A single instance of a Buckeye shoot with the leaves and buds in whorls of three has been observed by the author. Multiplication of parts has been observed in a number of cases. Three carpels instead of two have been found in the fruits of Big-leaf Maple (*Acer macrophyllum*). Three wings instead of one occur in one instance in a collection of achenes of Oregon Ash (*Fraxinus oregona*) gathered at St. Helena in 1907. Buckeye ovaries with four cells and eight ovules, and four valves to the pod, have been found near Berkeley.

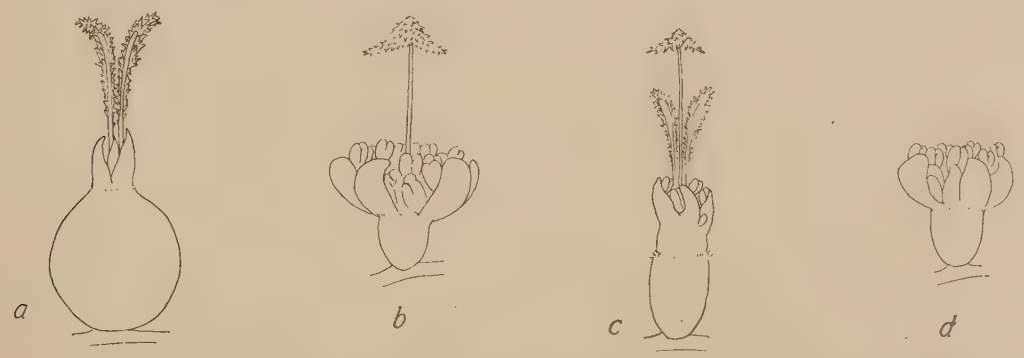


Fig. 9.—*Juglans californica* Wats. (California Walnut), teratological flowers. *a*, Pistillate flower with two normal styles. *b*, flower with stamens, ovary, style and discoid stigma. *c*, flower with stamens, ovary and three styles, two of the styles with normal stigmas, the third with discoid stigma. *d*, flower stamens and abortive ovary. All figures = × 7.

Abnormal flowers of *Juglans californica* have been collected from an indigenous tree at Garvanza, by E. B. Babcock. The pistillate flowers have become bisexual through the presence of about twelve to nineteen stamens. The staminate structures in these flowers do not among themselves differ obviously, but the pistils as to the stigmatic portion are of three types: (*a*) Stigmas two or three, large and very roughly pappillate; (*b*) Stigmas small, somewhat discoid and obscurely three-lobed, raised above the stamens on a slender stipe-like style three or four lines long; (*c*) Stigmas as in (*a*) but one style replaced by a structure as in (*b*). With this material is a staminate catkin, the anther-like bodies sterile, very much multiplied and coralline-branched.[10] (Fig. 9.)

## Leaf Persistence.

Our broad-leaved trees exhibit a number of peculiarities with reference to leaf fall. The Valley Oak and Blue Oak which normally lose their leaves in the late fall, may in favorable thermal belts in the foothills hold their leaves until Christmas or until the new leaves come in the spring, thus simulating the Coast Live Oak. The Mesa Oak holds its leaves regularly each winter until the appearance of the new leaves in spring and is on this account called "Evergreen White Oak." Coast Live Oak regularly sheds its leaves in March, just when the new growth begins. Interior Live Oak holds them over the flowering period and gradually drops them during the summer. Adult Oregon Oak trees lose their leaves in the fall, but young trees hold them all winter. The evergreen Madroña drops its old leaves in very midsummer—the ground being covered with them in early July. The new shoots of Laurel begin to grow in June and leaf fall is concurrent. Certain trees with compound leaves drop the leaflets first, the petiole persisting for a time, then falling. This is especially true of the Buckeye, less so of the native Walnut or of Oregon Ash.

Our coniferous trees are all evergreen. Most of the pines, such as Yellow Pine, Sugar Pine, Knob-cone Pine, Monterey Pine, Bishop Pine, Tamrac Pine, and Beach Pine, hold their leaves on lateral branches of adult trees two or three years. The leaves of the Foxtail Pine attain an age of ten to fifteen years before falling. Our firs hold their leaves three to ten years, the Tideland Spruce five to fourteen years, and our hemlocks three or four years. The leaves of Redwood and Big Tree are either separately deciduous or little branches rep-

[10] Since the above paragraph was written E. B. Babcock has sent the following note:

"The tree in question has two trunks. Fifty of the pistillate catkins borne upon one portion of the tree were examined and all the flowers were found to be normal. Every supposedly pistillate catkin examined upon branches arising from the other trunk bore teratological flowers, that is bisexual flowers. About twenty-eight of these supposedly pistillate flower clusters were covered with paper bags on the 25th of March. The stamens were not conspicuous on that date. On the 11th of April most of these clusters were examined without entirely removing the bags and the presence of pollen was observed. On the 8th of August, when the bags were removed, it was found that no nuts whatever had developed. It would appear in this case that sterility may be attributed largely to abortion of the gynoecium. However, such may not always be the case, and then it must be attributed to self-sterility of the flowers."

resenting one or usually two or three seasons' growth are shed as one piece, mainly in the autumn. In the former case the leaves are attached to more or less permanent branches. The extreme age of the leaves is about nine years in the Redwood and in the Big Tree. Douglas Fir holds its leaves three to nine years. The Western Yew and California Nutmeg retain the leaves from four to seven years.

Poplars and willows sometimes hold their leaves, especially in the top of the tree, until midwinter. The further southward the station the more likely is this to be the case. Arroyo Willow may hold its leaves until flowering time, in which case the catkins stand in the axils of the old leaves.

## Ages of California Trees.

No subject relating to the trees of California has offered a greater field for wild or exaggerated statements than the question of age. Even at the present time it is possible to present only fragmentary statistics of the ages of our trees because the subject requires many years to complete a thoroughgoing investigation. The tabulation which follows is made up from my own counts and estimates and from those made by Sudworth and Leiberg. Our data are too insufficient to attempt a column of extreme ages.

Age Table of California Trees.

| Species | Average Age of Mature Trees | Species | Average Age of Mature Trees |
|---|---|---|---|
| Yellow Pine | 250 to 400 | Redwood | 300 to 1500 |
| Jeffrey Pine | 150 to 200 | Incense Cedar | 100 to 250 |
| Sugar Pine | 350 to 450 | Monterey Cypress | 60 to 100 |
| Silver Pine | 150 to 225 | Sierra Juniper | 125 to 300 |
| Tamrac Pine | 75 to 150 | White Alder | 40 to 100 |
| Coulter Pine | 100 to 125 | Red Alder | 25 to 80 |
| Digger Pine | 75 to 175 | Valley Oak | 100 to 300 |
| Monterey Pine | 40 to 150 | Oregon Oak | 150 to 250 |
| Mountain Hemlock | 80 to 175 | Blue Oak | 80 to 300 |
| Douglas Fir | 200 to 350 | Coast Live Oak | 75 to 275 |
| White Fir | 175 to 380 | Black Oak | 100 to 200 |
| Red Fir | 250 to 400 | Tan Oak | 80 to 190 |
| Big Tree | 500 to 2300 | | |

Certain of our coast trees reach their adult height in thirty to fifty years. After this period they enter upon a more or less prolonged period of senility in which the top flattens, thickens or becomes dismantled. In this class fall Monterey Pine, Bishop Pine and Monterey Cypress. Trees of these species, even in the early period of senility, give the impression of being much older than they are.

The age of the Big Tree is a subject of great interest and has given opportunity in the popular literature for free play of the imagination and for vivid reference of the seedling stage of the present trees to various landmarks in man's ancient history. The age of the oldest trees is not easily determined and is a subject which gives rise to wide difference of opinion. The age of trees felled in lumbering is, however, easily determined. The stump of a tree at Atwell Mill 12½ feet in diameter showed 1485 rings. The first 43 inches contained 735 rings, the 32 inches outside 750 rings, thus averaging nearly 20 rings to the inch. These figures correspond fairly well with some counts made by others. Applying these figures to other trees whose trunks are up to 30 feet in diameter would give calculated ages varying from 2000 to 7000 years. Let us now check mere figuring with a specific case. The Father of the Forest is 27 feet in diameter across the stump inside the bark. Its calculated age, therefore, would be 6840 years. When cut down its actual age was found to be about 1300 years. Another instance may be given. In 1907 while in the Converse Basin I measured and counted the rings of fifteen trees. A tree 11 feet 7½ inches in diameter was determined to be 2017 years of age. Another tree over twice the diameter, namely 24 feet, was only 1346 years old. Obviously, then, the determination of the age of an individual tree by calculation is exceedingly unsafe. A summary of the 1907 measurements is as follows:

Age of Big Tree (Sequoia gigantea).

| No. | Diameter | Age | No. | Diameter | Age |
|---|---|---|---|---|---|
| 1. | 5 ft. 2 in. at 5 ft. | 257 | 9. | 11 ft. 10 in. at 7 ft. | 940 |
| 2. | 6 ft. at 3 ft. | 415 | 10. | 12 ft. 8 in. at 4 ft. | 928 |
| 3. | 6 ft. 8 in. at 6 ft. | 629 | 11. | 14 ft. at 7 ft. | 1095 |
| 4. | 7 ft. 5 in. at 4 ft. | 419 | 12. | 15 ft. 4 in. at 10 ft. | 2177 |
| 5. | 8 ft. 6 in. at 3 ft. | 428 | 13. | 17 ft. 7 in. at 4 ft. | 1300 |
| 6. | 9 ft. at 3 ft. | 421 | 14. | 17 ft. 9 in. at 9 ft. | 1606 |
| 7. | 9 ft. 4 in. at 8 ft. | 883 | 15. | 19 ft. at 7 ft. | 1560 |
| 8. | 11 ft. 7 in. at 12 ft. | 2017 | 16. | 24 ft. 2 in. at 5 ft. | 1346 |

All the above stumps were measured on logged areas in the Converse Basin except no. 16, the stump of which is at the upper Comstock Mill on Lime Kiln Creek. All my diameters are inside the bark.

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The literature consulted first and last during the progress of this investigation covers too wide a range to admit even a partially complete bibliography. The works cited below are those which have been most used for general reference or which have some special interest. In addition, under each species, there will be found a short reference list. The choice of citations in this latter case has been governed by the idea of including papers of the following character: those containing most morphological or physiological information; general revisions; those which would enable a chain of references to be picked up.

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## Nomenclature.

Until comparatively recent times the international language of botanists, the common medium of communication, was Latin. While most scientific papers are today written in the vernacular, scientific names for the sake of the widest intelligibility and definiteness are invariably written in Latin. It is, therefore, clear that international agreement, not local convention, should govern the choice of these Latin names since all nationalities have an interest in them. For this reason the binomial nomenclature of this volume is governed by the Rules of the Vienna International Congress of 1905—a congress that was representative of all the leading nations.

The choice of common names for our trees is not so easy as the determination of the proper scientific names. One species may have a half-dozen common names in different parts of the State; or one name may be applied to a half-dozen species in different parts of the State. Nevertheless common names are so useful and so indispensable that to the task of selection the author has exercised his best judgment in order to present a set of common names for our trees that will, he hopes, be acceptable because fortified by usage and by their aptness and fitness.

The best common names are those which are derived, as it were, from the soil. An excellent example is that of the Digger Pine, a name almost universally used by ranchmen, cattlemen, miners, and woodsmen. The objection which has been made to this name that it is not pretty, because of association with the Indian tribes, weighs not in the slightest with the author. The name is virile, historic, and apt. It comes from and is of the people. Such are the common names which deserve the widest usage, not the parlor names which are set up in the literature in opposition to them.

When a species has a dozen common names widest usage has governed the choice, as in case of the Maul Oak. When asked the name of this tree woodsmen, partly according to locality, will reply Cañon Oak, Spanish Oak, Georgia Oak, Florida Oak, Pin Oak, Valparaiso Oak, Iron Oak, Hickory Oak, Laurel Oak, Golden Oak, Drooping Oak; yet any one of them will almost invariably acknowledge that he knows also the name Maul Oak. The name Maul Oak is, therefore, selected because of widest usage, because of its aptness in telling a quality of the tree, and because the name belongs to no other oak.

Another case calling for decision is that of Redwood and Big Tree. While both species are of the Redwood genus, best as well as widest usage decrees that the name Redwood should be restricted to the coast species, *Sequoia sempervirens,* although it has been used in a few localities by the people for the Sierran species, *Sequoia gigantea.* Similarly Big Tree should be used only

for *Sequoia gigantea,* although it has likewise been locally applied to *Sequoia sempervirens.* The fact that Big Tree lumber is sold as Redwood is of no moment in this instance. Trade names give no certain clue to the proper appellations of trees. "Oregon Pine" lumber is not manufactured from a pine. Coast Hemlock lumber is sold as Alaska Pine, and yet any woodsman would recognize the tree as a hemlock and not a pine. Yet again, Yellow Pine lumber is sold as White Pine, and thus the instances might be multiplied.

No name among northern trees is so loosely applied as cedar. True cedars are of the genus Cedrus, the Lebanon Cedar and its varieties, and belong to the Pine Family. Nevertheless the name cedar with various modifying prefixes has been applied by the folk to a great variety of other trees. In many cases such names are so well established by usage as to be among our most useful vernacular names, as Incense Cedar, Canoe Cedar, Port Orford Cedar, and Nootka Cedar,—all species of the Cypress Family. There is also a disposition on the part of the people to apply the name cedar to our native Junipers. While such application to the Junipers is open to the criticism of being needless and confusing, it is less open to objection than the absurd attempt to foist upon our Monterey Cypress the name Lebanon Cedar. The loose usage of the name cedar among the people is further evidenced by its application to trees or shrubs which are not even coniferous. The "Desert Cedar" of the Colorado Desert is *Adenostoma sparsifolium* Torr., a shrub of the Rose Family.

## SYNOPSIS OF FAMILIES.

### GYMNOSPERMAE.

Trees or shrubs, ours evergreen with narrowly linear or scale-like leaves. Ovules borne naked. Cotyledons 2 to 17.

*Fruit a woody cone, containing several to many seeds.*

PINACEAE. Leaves narrowly linear; stamens with 2 pollen-sacs; ovules 2 to each scale; seed winged ..... p. 65.

TAXODIACEAE. Leaves narrowly linear or awl-like; stamens with 2 to 5 pollen-sacs; ovules 2 to 9 to each scale; seed not winged ..... p. 127.

CUPRESSACEAE. Leaves scale-like, thickly clothing the branchlets; stamens with 2 to 6 pollen-sacs; ovules 1 to several to each scale; seed winged or wingless ..... p. 147.

*Fruit berry-like or fleshy, one seed in a place.*

TAXACEAE. Leaves linear, 2-ranked; stamens with 4 to 9 pollen-sacs ..... p. 165.

### ANGIOSPERMAE.

Herbs, shrubs or trees. Ovules borne in a closed sac or ovary. Cotyledons 1 or 2.

#### MONOCOTYLEDONS.

Stems most commonly simple, the vascular bundles scattered through the pith. Leaves simple, parallel-veined. Flower-parts in 6s or 3s. Cotyledon 1.

LILIACEAE. Leaves mostly linear; flowers perfect; stamens 6; fruit a capsule ..... p. 169.

PALMACEAE. Leaves broad, plaited; flowers unisexual; stamens 6; fruit in ours a berry .... p. 171.

#### DICOTYLEDONS.

Stems most commonly branching, the vascular bundles at the beginning disposed in a ring. Leaves simple or compound, netted-veined. Flower-parts most commonly in 5s or 4s. Cotyledons 2.

##### FLOWERS IN CATKINS.

SALICACEAE. Flowers dioecious, both kinds in catkins; leaves simple; ovary superior; capsule dehiscent; seeds with a tuft of hairs ..... p. 173.

JUGLANDACEAE. Flowers monoecious, the staminate in catkins; leaves compound; ovary inferior; fruit a nut ..... p. 191.

BETULACEAE. Flowers monoecious, both kinds in catkins; leaves simple, ovary inferior; fruit 1-seeded, indehiscent ..... p. 196.

CUPULIFERAE. Flowers monoecious, the staminate in catkins; leaves simple; ovary inferior; fruit a nut ..... p. 202.

FLOWERS NOT IN CATKINS.

*Corolla when present choripetalous.*

LAURACEAE. Leaves simple, aromatic, corolla none; stamens 9; superior; fruit berry-like....p. 242.

PLATANACEAE. Leaves palmately lobed with prominent stipules; calyx and corolla minute; stamens and pistils in separate ball-like clusters scattered along a pendulous axis; ovary inferior; fruit an achene .....p. 247.

ROSACEAE. Leaves simple or compound; ovary superior or inferior; stamens 10 to many, perigynous; fruit various .....p. 249.

LEGUMINOSEAE. Leaves mostly compound; ovary superior; stamens 10; fruit a legume.....p. 256.

SAPINDACEAE. Leaves palmately compound; ovary superior; stamens 5 to 7; fruit a dehiscent pod .....p. 261.

ACERACEAE. Leaves mostly simple; ovary superior; stamens 3 to 10; fruit a samara .....p. 264.

CACTACEAE. Leaves reduced to scales or spines; flowers showy; stamens numerous; fruit fleshy .....p. 269.

CORNACEAE. Leaves simple; flowers small, in clusters, the parts in 4s; fruit a tiny drupe....p. 270.

*Corolla when present sympetalous.*

ERICACEAE. Leaves simple; ovary usually superior; corolla regular; stamens 5 or 10; fruit a capsule or berry-like .....p. 271.

OLEACEAE. Leaves compound in ours; ovary superior; stamens 2; fruit a samara .....p. 277.

BIGNONIACEAE. Leaves simple; corolla bilabiate; ovary superior; stamens 4; fruit dehiscent; seed winged .....p. 280.

CAPRIFOLIACEAE. Leaves simple or compound; corolla regular; stamens 4 or 5; fruit a berry.....p. 281.

# GYMNOSPERMS

Resinous trees or shrubs, ours evergreen with linear awl-like or scale-like leaves. Trunk usually persisting through the crown as a single axis, increasing in diameter by an annual layer of wood inside the bark. Sexual reproductive organs consisting of stamens and ovules. Stamens generally spirally arranged in a catkin-like cluster which falls after maturity. Ovules generally borne naked on the surface of a scale, the scales spirally arranged in a short catkin which commonly matures into a woody cone. Cotyledons several to many, sometimes only two.

## I. PINACEAE. Pine Family.

Trees or shrubs, typically with one main mast-like axis which bears laterally successive whorls of much-branched limbs. In the crowded forest the lower branches are shade-killed and fall, so that the trunk or axis supporting the cone-shaped crown is often naked for half or more than half its height. Stamens and ovules in different catkins on same tree. Staminate catkins with numerous spirally arranged stamens, each bearing two pollen-sacs and ending in a roundish crest or mere knob; pollen-grains usually with two bladder-like appendages to assist distribution by the wind. Ovulate catkins with spirally arranged scales, each subtended by a distinct bract; ovules naked, two at the base of each scale on the upper side, maturing into seeds which commonly bear a wing derived from the surface tissue of the scale. Fruit a woody cone, the scales much enlarged, the bracts remaining small or sometimes elongated and surpassing the scale.—Northern hemisphere, eight genera. California has endemic representatives of all the genera except Cedrus (Lebanon Cedar and varieties), Larix (Larch) and Pseudolarix (of China). The genus Larix has the needle-like deciduous leaves many in a cluster on short spur-like branchlets, and the small cones with the scales shorter than the bracts in the western species: L. occidentalis Nutt., Western Larch, leaves 3-angled, northern Oregon to British Columbia and northern Montana. L. Lyalli Parl., Lyall Larch, leaves 4-angled, Mt. Hood to British Columbia and east to the Rocky Mountains.

KEY TO THE GENERA.

Cones pendent or spreading, falling from the tree whole, the scales persistent.

Leaves of 2 kinds, needle-leaves in fascicles of 1 to 5 and scale-leaves; cones maturing the second year, their bracts minute ..... 1. PINUS.

Leaves of 1 kind, linear; cones maturing in the first year, their bracts obvious.

Bracts shorter than the scales; branchlets roughened by the persistent leaf bases.

Leaves petioled, jointed on the woody base which is somewhat decurrent on the branchlet; trunk bark fissured or smoothish, not scaly ..... 2. TSUGA.

Leaves sessile on the woody peg-like base which spreads at right angles to the branchlet; trunk bark marked by scars of deciduous scales ..... 3. PICEA.

Bracts longer than the scales, notched at apex with a spear-like point in the notch; leaf-scars smooth; old bark very rough ..... 4. PSEUDOTSUGA.

Cones erect on branch, maturing the first year, its scales falling separately; leaf-scars smooth ..... 5. ABIES.

## 1. PINUS L. PINE.

Trees with two sorts of leaves, the primary leaves thin and scaly or chaff-like, bearing in their axils needle-shaped leaves in fascicles of 2 to 5, which emerge from slender buds whose scarious scales sheathe the base of the cluster. Staminate catkins spreading, crowded in a whorl at the base of the shoot of the same spring. Ovulate catkins erect, 1 to 8 in a lateral or sub-terminal whorl. Cones maturing in the second year, reflexed or pendulous, their scales woody, imbricated, the exposed portion (apophysis) often much thickened and bearing centrally an elevated scar or prickly boss (umbo). Cotyledons 4 to 17.—The genus Pinus, consisting of about seventy species distributed over the northern hemisphere and replaced in the southern hemisphere by the genera Araucaria and Podocarpus, is strongly represented in California, no other region relatively to area being so rich in species.

KEY TO THE SPECIES.

WHITE PINES.—Cones subterminal, the apophysis of the cone-scale usually thin and unarmed; needles in 5s; wood light-colored, soft; chiefly high montane.

Cones long-stalked, very long and slender when closed.

Needles 1 to 3¾ inches long; cones 6 to 8 inches long; high ranges ..... 1. *P. monticola.*

Needles 2 to 3½ inches long; cones 13 to 18 inches long; high ranges ..... 2. *P. Lambertiana.*

Cones with short stalks or almost none; needles 1 to 2½ inches long.

Scales very thick at tip, not closely overlapping; cones subglobose, 1 to 3 inches long; high montane ..... 3. *P. albicaulis.*

Scale-tips slightly thickened, rather closely overlapping; cones commonly long-ovate, 2 to 5 inches long; desert mountains chiefly ..... 4. *P. flexilis.*

YELLOW PINES.—Cones subterminal, sessile or nearly so, the scales with a thick apophysis which is umbonate and armed with a prickle; needles in 5s, 3s, or 2s; wood very pitchy.

Needles in 5s.

Cones oblong-ovate, 2½ to 5 inches long; scales with minute prickles; needles ¾ to 1 inch long; Mt. Whitney region and high North Coast Ranges ..... 5. *P. Balfouriana.*

Cones slender-ovate, 3 to 3½ inches long; scales with long slender prickles; needles 1 to 1½ inches long; desert ranges ..... 6. *P. aristata.*

Needles in 3s, 5 to 10 inches long; cones breaking through near base when falling, some scales remaining on branch.

Cones ovate, 3 to 5 inches long; common at middle altitudes ..... 7. *P. ponderosa.*

Cones round-oval, 5 to 10 inches long ..... 7*a*. Var. *Jeffreyi.*

Needles in 2s, 1¼ to 2¾ inches long; cones 1 to 1¾ inches long.

Bark thin, smooth; high montane ..... 8. *P. Murrayana.*

Bark thick, rough; seashore ..... 9. *P. contorta*

NUT PINES.—Cones lateral or subterminal, the scales strongly thickened at tip or prolonged into conspicuous spurs or hooks; seeds large, thick-shelled, the wing short or none; needles 1 to 5 in a cluster; arid areas and chiefly low altitudes.

Cones very large, with highly developed spurs, breaking through near base when falling, a few lower scales persisting on the branch; needles in 3s.

Cones ovate, 10 to 13 inches long; needles erect, 5 to 14 inches long; trunk persisting through crown as one main axis; foliage yellowish; South Coast Ranges ..... 10. *P. Coulteri.*

Cones round-oval, 6 to 10 inches long; needles drooping, 7 to 13½ inches long; trunk branching into several secondary axes; foliage gray; dry interior foothills ..... 11. *P. Sabiniana.*

Cones with pyramidal apophyses.

Needles in 5s, 7 to 10 inches long; cones triangular-oval, 4 to 5½ inches long; scales with pyramidal apophyses; local on south coast ..... 12. *P. Torreyana.*

Needles commonly in 4s, ¾ to 1¾ inches long; cones subglobose, 1¼ to 2 inches long; Southern and Lower California ..... 13. *P. Parryana.*

Needles 1 in a place, 1½ to 2 inches long; cones subglobose, 2½ to 3½ inches long; desert region ..... 14. *P. monophylla.*

CLOSED-CONE PINES.—Cones lateral, sessile, one-sided, opening tardily, often remaining closed for many years, their scales conspicuously swollen at tip; needles in 3s or 2s; lower altitudes, chiefly of coast.

Needles in 2s, 4 to 6 inches long; cones ovate, 2 to 3 inches long, often developing stout spurs; seashore ..... 15. *P. muricata.*

Needles in 3s.

Cones broadly ovoid, 2½ to 4½ inches long; needles 3 to 6 inches long; seashore ..... 16. *P. radiata.*

Cones oblong-ovate, 3 to 6 inches long; needles 3 to 5 inches long; montane ..... 17. *P. tuberculata.*

## 1. **Pinus monticola** Don.

### Silver Pine.

Pl. 15, figs. 3, 4, 5.

Pinus monticola Don in Lambert, Pinus, vol. 3, p. 27, t. (1837); Loudon, Arb. Britt., vol. 4, p. 2291, figs. 2208, 2209 (1838); Gordon, Pinetum, p. 233 (1858); Engelmann, Bot. Cal., vol. 2, p. 123 (1880); Kellogg, For. Trees Cal., p. 38 (1882); Lemmon, 2d Rep. Cal. Board For., p. 79 (1888); Sargent, Gard. & For., vol. 5, p. 1, fig. 1 (1892); Merriam, Biol. Sur. Mt. Shasta, pp. 38, 136 (1899); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 539 (1900); Howell, Flora N. W. Am., p. 791 (1903).

Forest tree, 50 to 175 feet high, the branches slender and spreading or somewhat drooping and mostly confined to the upper portion of the shaft; trunk 1 to 6 feet in diameter, clothed with a very smooth though slightly checked whitish or reddish bark; needles 5 (rarely 4) in a place, very slender, 1 to 3¾ inches long, sheathed at base by thinnish narrow deciduous scales, some of which are 1 inch long; staminate catkins 3 or 4 lines long, 6 or 7 (or more) in a cluster; ovulate catkins borne near the ends of high branches on long stalks; cones in clusters of 1 to 7, pendulous, 6 to 8, or rarely 10 inches long, very slender when closed and usually curved towards the tip, black-purple or green when young, buff-brown at maturity, 2½ to 3½ inches broad near the base when open and tapering to the apex; scales thin, soft, smooth, widening from the base to the rounded apex, chocolate-brown except the exposed portion or apophysis, which is buff and bears a terminal scar-like umbo; seeds 3 to 4 lines long, their wings about 3 times as long, widest at the middle; cotyledons 5 to 9, mostly 7 or 8.

The Silver Pine, often called Mountain Pine or Western White Pine, inhabits the main timber belt of the Sierra Nevada from 6000 to 9500 feet, often associating with the Sugar Pine, but ranging to slightly greater altitudes. On Mt. Shasta it occurs up to 7200 feet and also grows in the Cascade Mountains as far north as southern British Columbia, thence east to northwestern Montana. It is absent from Southern California, and from the Coast Ranges except from the far north Coast Ranges, where it occurs sparingly as a scattered tree in the forests on the high Trinity Mountains, Marble Mountain and the Siskiyous.

In 1900 I found it on the Poison Meadow Trail between the Grand Cañon of the Kern River and the headwaters of the Little Kern. Thence northward through the timber belt of the Sierra Nevada it is scattered through the forest as single trees or a few together, rarely forming even one-tenth of the stand on limited areas. Its extreme age is about 400 years. At high altitudes it is often distorted or dwarfed. Everywhere it shows great weakness in its power to establish seedlings and on this account its forestral importance will grow less and less, although it has a high value as a timber tree. The freedom of the shaft from limbs and the maintenance of its diameter well upwards recommend it,

while the qualities of the wood are such that it is used to advantage as a substitute for Sugar Pine. The heart-wood is, however, not so white, being brown or reddish, although quite as soft, which explains the name "Soft Pine" of the woodsmen. "Western White Pine" is a name used by loggers and lumbermen. "Little Sugar Pine" is a folk-name in rather wide use.

The Mountain Pine is best recognized by its light gray smooth bark broken into squarish plates, its pale blue-green foliage composed of short needles and its pendulous cones so slender as to give rise to the name "Finger-cone Pine." It was discovered by David Douglas on the high mountains near the Grand Rapids of the Columbia River in 1831 and afterwards on the banks of the Spokane River.

### 2. **Pinus Lambertiana** Dougl.

#### Sugar Pine.

Plate 15, figs. 1, 2; plate 4.

Pinus Lambertiana Douglas, Trans. Linn. Soc., vol. 15, p. 500 (1827), Comp. Bot. Mag., vol. 2, pp. 92, 106, 107, 130, 152 (1836); Nuttall, Sylva, vol. 2, p. 180, t. 114 (1865); Hartweg, Jour. Hort. Soc. London, vol. 3, p. 225 (1848); Bigelow, Pac. R. Rep., vol. 4, pt. 5, p. 21 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 42, fig. 14 (1857); Gordon, Pinetum, p. 228 (1858); Bolander, Proc. Cal. Acad., vol. 3, p. 226 (1866); Engelmann, Bot. Cal., vol. 2, p. 123 (1880); Kellogg, For. Trees Cal., p. 39 (1882); Lemmon, 2d. Rep. Cal. Board For., p. 80 (1888), Bull. Sierra Club, vol. 2, p. 65, pl. 12, fig. 1 (1897); Parish, Zoe, vol. 4, p. 350 (1894); Davy, Erythea, vol. 4, p. 152 (1896); Sargent, Silva N. Am., vol. 11, p. 27, t. 542, 543 (1897); Veitch, Man. Conif., p. 336 (1900); Sudworth, 21st Rep. U. S. Geol. Surv., pt. 5 (For. Res.), p. 522 (1900); Jepson, Fl. W. Mid. Calif., p. 20 (1901); Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, p. 25 (1902); Cooper, U. S. For. Service Bull., no. 69 (1906).

Forest tree 80 to 250 feet high, the young and adult trees symmetrical, but the aged trees commonly with broken summits or characteristically flat-topped with 1 or 2 long arm-like branches exceeding shorter ones; trunk 2 to 8 feet in diameter, its bark brown or reddish, closely fissured into rough ridges; needles slender, 5 in a bundle, 2 to 3½ inches long; staminate catkins yellowish brown, 3 to 4 lines long, 15 to 25 in a cluster, their pollen-sacs with broad or roundish minutely erose crests; cones pendulous, borne on stalks at the ends of the branches, mostly in the very summit of the tree, very long-oblong, 13 to 18 inches long, 4 to 6 inches in diameter when opened; scales broad, only slightly thickened, rounded at apex and tipped with a terminal scar-like umbo; seeds 4 to 7 lines long with wings twice as long and broadest near the middle; cotyledons 13 to 15.

The Sugar Pine, one of the most characteristic species of the timber belt of the Sierra Nevada, ranges south to the high mountains of Southern California and San Pedro Martir in Lower California and north to the Cascades and Coast Ranges of Oregon. It is uncommon in most parts of the California Coast

Ranges because the altitudes are not sufficient for its growth, but its distribution may be indicated as follows: it occurs on the high summits of the Siskiyou, Humboldt and Trinity mountains, and forms a part of very considerable forests on the Yollo Bollys, especially on the eastern slope facing the Sacramento Valley; thence it ranges southward to Snow Mountain, Cobb Mountain, the neighborhood of Mt. St. Helena, and the headwaters of Austin Creek in Sonoma County, where it occurs very sparingly.[1] Southward there is a broad gap in its distribution and it is not again encountered until found in the Santa Lucia Mountains. The earlier botanical explorers, Coulter, Douglas, Hartweg, Lobb, and Beardsley, saw it in the Santa Lucias, but an exact locality was not given for it in this range until recorded in Erythea (vol. 5, p. 74) in 1897. There are no other stations on record for this pine in the South Coast Ranges north of Santa Barbara.

While thus absent from or rare in most parts of the Coast Range, it is most abundant and attains most perfect development on the western slope of the Sierra Nevada, where in company with the Yellow Pine and White Fir it is an important element in the main coniferous belt at an altitude of 6000 to 7000 feet in the south and 2500 to 5000 feet in the north. It ranges, however, as low as 2000 feet. It is not, however, abundant as compared with either the Yellow Pine or White Fir, since it forms only about 14 per cent. of the total stand in the Yellow Pine (Transition) Zone, although there are favored localities of restricted area, where it makes up 20 to 60 per cent. of the total stand. These heavy stands are at 4000 to 5000 feet elevation. At the lower limits, 2500 to 3000 feet, the percentage averages 5 per cent. or less. The Sugar Pine forms a trunk of the highest commercial type; nearly the whole tree is capable of being converted into lumber because the trunk holds its diameter upwards so well and limbage is so small. Where Sugar Pine, then, occurs in great abundance it follows that the stands are from the standpoint of quantity as well as quality very valuable. Small areas which will yield 100,000 to 200,000 feet to the acre are known but are comparatively rare. No other pine is so valuable for its wood or will show so great a yield per acre.

Its wood is light, soft, close-grained, fairly strong, works easily, takes a fine polish and is delightfully fragrant. It is used for doors, window-sashes, interior finish and for all purposes where a high-class soft wood may be utilized. It is so much less abundant than the Yellow Pine and Red Fir that the wood is already becoming high priced. When manufactured into lumber it requires more care in handling than Yellow Pine, Incense Cedar or White Fir. It demands immediately a certain amount of air for seasoning, otherwise if piled

[1] It also occurs on Buckeye Creek, a branch of the Gualala River, north of the village of Annapolis, on a slope near the Sonoma-Mendocino boundary, at an altitude of 1000 feet. Trees were noted standing within fifty feet of Redwood (*F. W. Koch*, 1909).

solid in the yards it will sweat and stain so as to ruin its appearance and unfit it for use in natural wood finishing.

The vagrant shake-maker is still a more or less familiar character in the beautiful Sierran woods. Needing only a simple outfit he finds the choicest of all pine trees admirably adapted for his purposes. Even as shake-making his ways are highly scornful of economy of the forest; for if a felled tree show a grain unsuited to clean splitting it is easily abandoned, left to rot on the ground or to be eaten up by the first forest fire. With the passing of the shake-maker will pass also the old time sheep-herder who built sheep corrals in the edge of the meadows or on the ridges by the simple process of felling Sugar Pine trees in such a way that, stretched at length on the ground, the great logs formed a sort of huge circular or triangular enclosure. Even more wantonly destructive, however, are ranchmen who enclose their range by so felling Sugar Pine, Yellow Pine and Fir logs end to end as to make a fence that easily turns cattle.

Under natural conditions Sugar Pine reproduces itself fairly well, but is less persistent than Yellow Pine. The lumbering companies in the Sierra Nevada seldom leave a seed tree by design and in the cut-over lands its shy seedlings are a rarity as compared with the aggressive Yellow Pine. It is doubtful if it ever returns naturally to some areas where it has been completely cut away, on account of the lack of moisture and proper shade.

Sugar Pine derives its name from the sugary exudation, sought by the native tribes, which forms hard white crystalline nodules on the upper side of fire- or axe-wounds in the wood. This flow contains little resin, is manna-like, has cathartic properties and is as sweet as cane-sugar, but belonging to a different class of sugars, namely pinite or pine-sugar. The nodules are soluble in water, nearly insoluble in alcohol and not fermentable.

The seeds are edible. Although very small they are more valued by the native tribes than the large seeds of the Digger Pine on account of their better flavor. In former days, when it came October, the Indians went to the high mountains about their valleys to gather the cones. They camped on the ridges where the Sugar Pines grow and celebrated their sylvan journey by tree climbing contests among the men. In these latter days, possessed of the white man's axe, they find it more convenient to cut the tree down.

The Sugar Pine and the name of David Douglas, botanical explorer, are inseparably linked. From 1824 to his death in 1833 Douglas was in the service of the London Horticultural Society. A born enthusiast, hardy of body, self-reliant and highly resourceful—especially in meeting hostile or tricky savages—he explored portions of Oregon and Washington and later of California. In his journal, a highly entertaining narrative, is told the story of his adventurous journey from the Columbia River to the headwaters of the Umpqua River in search of the Sugar Pine, the seeds of which he had seen in the tobacco pouch of

an Indian on the Columbia. Douglas recognized the species as new and named it in honor of his friend Lambert, a founder of the Linnean Society of London and the author of a sumptuous work on pines.

The Sugar Pine is undoubtedly the most remarkable of all pines, viewed either from the standpoint of its economic value or sylvan interest. While it is only in limited areas, even in the Sierra Nevada, that it is a dominant species, on the other hand single trees are scattered everywhere in the forest and lend an added charm to the woods of that great mountain chain. It is the largest of pine trees, considered either as to height or girth, and more than any other tree gives beauty and distinction to the Sierran forest.

### 3. **Pinus albicaulis** Engelm.

WHITE-BARK PINE.

Plate 16, figs. 1, 2; plates 5, 17.

PINUS ALBICAULIS Engelmann, Trans. St. Louis Acad., vol. 2, p. 209 (1863); Coville, Bot. Death Val. Exped., p. 221 (1893); Sargent, Silva N. Am., vol. 11, p. 39, t. 548 (1897); Merriam, Biol. Sur. Mt. Shasta, pp. 39, 137 (1899); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For Res.), pp. 517, 541 (1900); Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, p. 25 (1902).

*Pinus flexilis* var. *albicaulis* Engelmann, in Bot. Cal., vol. 2, p. 124 (1880).

*Pinus cembroides* Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 44, 90 (1857), not Zuccarini.

Sub-alpine tree, usually dwarfish or prostrate in habit, often with two or three main stems from the base, 2 to 20 or 40 feet high; bark thin, whitish and smooth, or fissured into scaly plates on the main trunk, which is ½ to 2 feet in diameter; needles 5 in a cluster, 1 to 2½ inches long, persisting 5 to 7 years, but clothing only the tips of the slowly growing branchlets; staminate catkins globose, bright pink; cones ovoid or subglobose, yellowish brown, 1 to 3 inches long and nearly as thick; scales broad, rounded at apex and with a short acute terminal umbo, not overlapping closely but their tips strongly thickened and either projecting freely or presenting very bluntish points; seeds obovate, acute, not compressed or only on one side, obscurely margined towards the point, 4 to 6 lines long; wing narrow, usually persistent on the scale; cotyledons 7 to 9.

The White-bark Pine inhabits rocky slopes, ridges, or cirques and is the characteristic tree at and near timber line throughout the Sierra Nevada from Mt. Whitney to Mt. Shasta, thence west to the Scott Mountains and north to British Columbia and western Montana. In all the southern half of the Sierra chain its altitudinal range is from 9500 to 11,000 feet and in the northern half 7500 to 9500 feet. Exposed to the most extreme climatic conditions known in California, the trees invariably show the effects of cold and wind in their slowness of growth and exceedingly varied outlines. Old but erect trees are irregular in figure with trunks thickened out of all proportion to the size of

the crown, a characteristic feature of sub-alpine arborescent growth. At the upper limits it often forms broad mats hugging closely to rocky ridges. Trees growing in cirques or in places where the snow drifts or accumulates are often only two or three feet high with broad flat tops, which on account of the denseness of the foliage and branchlets are very like low tables. Travelers with an inquiring spirit essay to walk across the top of them, since their shape rather invites the trial. The slowness of the growth is shown both by the narrow rings of the wood and the ring-scars of the terminal buds. Branchlets but four or five inches long are often twelve to seventeen years of age. (Plate 17.)

The stand of White-bark Pine is very thin on account of uncertain reproduction. Cones are sparingly produced. Furthermore it is but rarely that one finds a good mature cone full of seed, on account of the industry of the crows and sub-alpine squirrels. By reason of the high altitude seedlings suffer from the extreme cold and, as Sudworth notes, from being whipped against rocky surfaces or from the cutting of sharply broken granite gravel driven by the furious winds at high altitudes.

*Pinus albicaulis* was first discovered September 23, 1851, on the summit of a mountain near Fort Hope in British Columbia by John Jeffrey. In 1855 it was collected by Dr. Newberry in the Cascade Mountains of Oregon about latitude 44°. He made the first field studies and it was, apparently, from his material that Engelmann described this pine as a distinct species.

### 4. **Pinus flexilis** James.

LIMBER PINE.

Plate 16, figs. 3, 4; plate 18.

PINUS FLEXILIS James, Long's Exped., vol. 2, p. 35 (1823); Bigelow, Pac. R. Rep., vol. 4, pt. 5, pp. 6, 20 (1856); Nuttall, Sylva, vol. 2, p. 167, t. 112 (1865); Watson, Bot. King, p. 332 (1871); Engelmann, Bot. Cal., vol. 2, p. 124 (1880); Sargent, Silva N. Am., vol. 11, p. 35, t. 546 (1897); Coville, Bot. Death Val., p. 221 (1893); Hall, Univ. Cal. Publ. Bot., vol. 1, pp. 24, 53 (1902).

*Pinus albicaulis* Parish in Zoe, vol. 4, p. 350 (1894), not Engelmann.

Tree 10 to 60 feet high with a short trunk 1 to 3 feet in diameter; needles 5 in a cluster, 1 to 2¼ inches long, often curving, densely clothing the ends of the branchlets, and forming a sort of brush; catkins reddish or red purple; cones buff or olive-buff, globose to long-ovate in outline, and 2 to 5 inches long; scales broad with rounded slightly thickened tips and terminal scar-like umbo, overlapping rather closely and leaving only a narrow portion free on the upper side the scale; seeds nearly oval, markedly compressed, surrounded by an acute margin, 4 or 5 lines long; wing narrow, generally persistent on scale; cotyledons 6 to 9.

The Limber Pine is a tree of the desert mountains, where it grows on the arid rocky slopes at 5000 to 11,000 feet above sea-level. It occurs in the Rocky Mountains from Montana to Texas and on all the desert ranges westward through Arizona and Nevada to the summits of the Charleston, Panamint and Grapevine mountains in the Death Valley region of California. It is also found on the eastern slope of the Sierra Nevada in Mono and Inyo counties and on the San Bernardino, Sierra Madre and San Jacinto ranges. In the three latter ranges it is found chiefly, if not entirely, above 9000 feet and is most commonly associated with *Pinus Murrayana;* these two species are the only trees at the highest altitudes. The trees grow on the very summit of El Toro Peak in the San Jacinto range and are ten to eighteen feet high, the largest trunks two feet in diameter. The pure stand on this peak is illustrated in plate 18. The most westerly station is Mount Pinos, where a few trees, according to H. M. Hall, are found on the summit at 8800 feet and along the north side; none of the trees are over forty feet high nor over two feet in diameter.

In southern Nevada it is commonly called White Pine and gives the name to the White Pine Mountains. It is, in the desert region, a valued timber tree and was the most important lumber resource for the towns of White Pine County in Nevada before the days of railway transportation.

### 5. **Pinus Balfouriana** Jeffrey.

FOXTAIL PINE.

Plate 16, figs. 5, 6; plate 19.

PINUS BALFOURIANA Jeffrey, Oreg. Exped., 1, t. 3, fig. 1 (1853); Gordon, Pinetum, p. 217 (1858); Engelmann, Bot. Cal., vol. 2, p. 125; Lemmon, 2d Rep. Cal. Board For., pp. 71, 86, t. 5 (1888); Coville, Bot. Death Val., p. 221 (1893); Sargent, Silva N. Am., vol. 11, p. 59, t. 553 (1897); Jepson, Sierra Club Bull., vol. 4, p. 214, pl. 75 (1903).

*Pinus Balfouriana* Murray, var., Engelmann in Bot. Wheeler Rep., p. 375 (1878).

Subalpine tree, commonly 20 to 45 feet high, with cone-shaped trunk 1 to 4 feet in diameter at the base, the axis in old or in storm-beaten trees at timber line projecting through the crown as a dead and shining splinter point; bark reddish brown, smoothish but superficially checked; branches stout and rather short with half-drooping branchlets thickly clothed with short needles spreading equally all around and thus resembling a fox's tail; needles in 5s, bright green on the upper side, glaucous on the lower, ¾ to 1 inch long, remaining on the tree 10 to 15 years; catkins reddish or purplish; cones slender when closed, oblong-ovate in outline when open, terra-cotta in color, 2½ to 5 inches long, and 1¾ to 2 inches broad; tips of the scales thickened or low-pyramidal, with shrunken scar-like umbo; seeds 3½ to 4 lines long, their wings narrow, 6 to 11 lines long; cotyledons 5.

The Foxtail Pine, often called Balfour Pine, is a local species growing on the granite at high elevations in the mountains of California. It is limited to two widely sundered centers of distribution, one in northwestern California, the other in the southern Sierra Nevada. In the former region it occurs in Siskiyou County from the Scott Mountains westward to Marble Mountain at an altitude of 6000 to 8000 feet, thence southward to Yollo Bolly in Trinity County. In the southern region it occurs at 10,000 to 11,000 feet on the west and south sides of Olanche Mountain, where it forms a distinct belt, and thence northward in scattered groves to the headwaters of the South Kings River.[2] In this latter region a few trees are found at 8000 feet on Bubbs Creek under the West Vidette, while towards Kearsarge Pass the species forms 15 to 25 per cent. of the thin subalpine forest. In the Kaweah Basin it is found on Mt. Silliman, Alta Peaks, and at the head of the Middle and East Fork Kaweah basins. It is also reported at head of Middle Tule River.

The most extensive forest of Foxtail Pine occurs on the Whitney Plateau, east of the grand cañon of the Kern River, a granite tableland 9000 to 11,000 feet in altitude. It is on the whole a thin forest, though mostly pure except when mixed with Tamrac Pine, as at the timber line on Mt. Whitney. The Chagoopah Plateau, of similar elevation, lies on the opposite side of the Kern River. Its forest contains a fine assemblage of Tamrac Pine, Red Fir and Silver Pine, with the Foxtail Pine on the western edge of the plateau, that is, at and near the timber line of the Sawtooth Range. The trail from the Big Arroyo over the granite country to Quinns Pass is faintly traced through a cirque near the head of Soda Cañon. In this cirque the physical surroundings of the Foxtail Pines and their habits of growth are well illustrated. Of arboreous or even woody growth this species is here the only representative. Its physical isolation is all the more emphasized by the scarcity of even herbaceous growth in the granite sand which covers the floor and slopes of the cirque.

*Pinus Balfouriana* was discovered by the botanical explorer John Jeffrey "on a range of mountains between Shasta and Scott's Valley," northern California, elevation 5000 to 8000 feet, September 29, 1852, and named by the collector for his friend, Professor John Hutton Balfour of Edinburgh University.

### 6. **Pinus aristata** Engelm.

HICKORY PINE.

PINUS ARISTATA Engelmann, Am. Jour. Sci., ser. 2, vol. 34, p. 331 (1862); Coville, Bot. Death Valley Exped., p. 220 (1893); Sargent, Silva N. Am., vol. 11, p. 63, t. 554 (1897).

*Pinus Balfouriana* var. *aristata* Engelmann in Bot. Cal., vol. 2, p. 125 (1880); Veitch, Man. Conif., in p. 314 (1900).

[2] It also occurs at the head of the North Fork Kings River and of South Fork San Joaquin River.

Usually a bushy tree 15 to 40 feet high; leaves 1 to 1½ inches long; cones slender ovate, 3 to 3½ inches long, the scales armed with slender prickles 3 lines long.

The Hickory Pine, also called Foxtail Pine, ranges from Colorado westward to southern Nevada and barely enters California on the summits of the Charleston, Panamint and Inyo mountains of the desert region. By some authors it is not regarded as other than varietally distinct from *Pinus Balfouriana.* The Mt. Silliman locality reported in the Botany of California is a mistaken identification of *Pinus albicaulis,* which is common at the higher altitudes on that mountain.

### 7. **Pinus ponderosa** Dougl.

YELLOW PINE.

Plate 20, figs. 1, 2; plate 4.

PINUS PONDEROSA Douglas in Lawson, Man., p. 355 (1836), Comp. Bot. Mag., vol. 2, p. 111 (1836); Loudon, Arb. Britt., vol. 4, p. 2243, figs. 2132-2136 (1838); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 36, pl. 4 (1857); Gordon, Pinetum, p. 205 (1858); Engelmann, Bot. Cal., vol. 2, p. 125 (1880); Stearns, Am. For. Assoc. (1882); Lemmon, 2d Rep. Cal. Board For., p. 97 (1888); Sargent, Silva N. Am., vol. 11, p. 77, tt. 560, 561 (1897); Lloyd, Ann. N. Y. Acad., vol. 11, p. 45, pl. 1 (1898); Sudworth, 21st Rep. U. S. Geol. Surv., pt. 5 (For. Res.), pp. 516, 520 (1900); Jepson, Fl. W. Mid. Cal., p. 21 (1901); Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, p. 26 (1902); Hall, Univ. Cal. Publ. Bot., vol. 1, p. 20 (1902); Howell, Fl. N. W. Am., p. 791 (1903).

*Pinus Benthamiana* Hartweg, Jour. Hort. Soc. Lond., vol. 2, p. 189 (1847); Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 212, t. (1849), Pinetum, p. 188 (1858); A. Murray, Edinb. New Phil. Jour., n. ser., vol. 1, p. 287, t. 8 (1855).

*Pinus Beardsleyi* Murray, Edinb. New Phil. Jour., n. ser., vol. 1, p. 286, pl. 6 (1855).

*Pinus Craigana* Murray, Edinb. New Phil. Jour., n. ser., vol. 1, p. 288, pl. 7 (1855).

*Pinus Engelmanii* Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 141 (1857) not of Carr.

*Pinus Parryana* Gordon, Pinetum, p. 202 (1858).

Forest tree 60 to 225 feet high with trunk 2 to 9 feet in diameter; limbs in mature trees horizontal or even drooping, the lower ones in dense stands regularly deciduous upwards and giving clear shafts 40 to 100 feet in length; bark in typical trees tawny yellow or yellow-brown, divided by fissures into large smoothish or scaly-surfaced plates which are often 1 to 4 feet long and ½ to 1¼ feet wide; needles in 3's, 5 to 10 inches long; staminate catkins purple, 8 to 38 in compact rosette-like clusters, at first conic-cylindric and ¾ to 1¼ inches long, later (when shedding pollen) becoming more slender and 1 to 2 inches long; ovulate catkins purplish, oblong-ovate, 6 to 8 lines long; cones reddish brown, narrowly ovate when closed, roundish ovate or oval when open, commonly 3 to 5 inches long; after opening breaking through near the base and falling, leaving the basal scales on the limb; scales thickened or low-pyramidal at apex and

bearing an umbo which is abruptly drawn down into a stout somewhat triangular point or short prickle; seeds ovatish, sometimes slightly flattened at apex, 3 to 5 lines long, the wing broadest near the middle and tapering to apex, ¾ to 1 inch long and 4½ to 5½ lines broad; cotyledons 6 to 9.

The Yellow Pine, or more specifically Western Yellow Pine, is distributed through the Sierra Nevada and Coast Ranges, southward to northern Mexico, eastward to the Rocky Mountains and northward to British Columbia. It inhabits plateaus, slopes, ridges, cañon walls, granite cliffs in the mountains and gravelly floors of valleys. It ranges altitudinally from near sea-level to 7000 to 8000 feet. It grows on rocky beds or in sandy soils, and in clays and loams. It occurs where there is a high annual rainfall and in regions of semi-drought. It is found in sheltered situations or on the most exposed areas, in warm valleys where the snow rarely falls or in mountain cañons where snow-drifts 100 feet deep lie all winter long. It is an exceedingly hardy tree and is inured to a wider range of physical conditions than any other member of the North American silva. This generalization also applies specially to California, where it is more common and more widely distributed than any other tree in the State.

Throughout the entire length of the Sierra Nevada it is the dominant tree between 4000 and 6000 feet in the south and 2500 and 5000 feet in the north, and forms in company with the White Fir, Incense Cedar and Sugar Pine a forest belt remarkable for the uniformity of the stand, the size and height of the trees, their straight clear trunks, and the open character of the forest floor beneath them. Nearly or quite one-half of the lower forest belt consists of Yellow Pine and in favored localities it spreads to lower or to higher altitudes as thin colonies or as scattered individuals.

The distribution of the Yellow Pine in the Coast Ranges is far less uniform on account of the great variability in climate, in topography, and in altitude of the mountain peaks and ridges, and their varying distance from the ocean. It forms a rather marked belt on the summits of ranges exceeding on an average 3000 feet, but in the North Coast Ranges, especially north of Long Valley, Mendocino County, it is often found on mountain sides at much lower elevations. Furthermore, it inhabits gravelly drifts in certain valleys very near sea-level as in Napa and Knights valleys (175 to 320 feet altitude), or in Ukiah, Sherwood and Long valleys (600 to 1500 feet). It is abundant in the Yollo Bolly Mountains at 4000 to 5000 feet and extends westward to the borders of the Redwood Belt in Mendocino and Humboldt counties as a much scattered growth, and southward along the Mt. St. Helena Range as far as Howell Mountain, where there are (or were) fine groves on the plateaus at 2200 feet elevation. It is a scarce tree in the seaward Sonoma ranges, and is altogether absent from that southerly portion of the inner North Coast Range known as the Vaca Moun-

tains. In the region south of San Francisco Bay it is absent from the Mt. Diablo Range, but is common on the highest summits of the Mt. Hamilton Range and occurs in the Santa Cruz Mountains, San Carlos Mountains, and Santa Lucia Mountains. In Southern California it is always the most important tree in the timber belt crowning the San Rafael, Sierra Madre, San Bernardino, and San Jacinto ranges, and the mountains of Palomar and Cuyamaca.

The bark of *Pinus ponderosa* is exceedingly variable. Black-barked or brown-barked trees, roughly or narrowly fissured, are very common and in their extreme forms very different in trunk appearance from the typical or most abundant "turtle-back" form with broad, yellow, or light brown plates. The quality of the wood varies also in different individuals and in the view of many woodsmen this difference corresponds to differences in the bark, all of which indicates the significance of their local names, "Black Pine," "Bull Pine," "Jack Pine," and "Yellow Pine." The botanist, however, does not find any technical differences amongst these forms nor do the variations in the bark safely indicate the quality of the wood any more than in some other species. In some localities the axes of old Bull Pines tend to part into two or three parallel fingers at the summit with the branches ascending or horizontal, while typical Yellow Pine usually bears declined branches.

The wood of the Yellow Pine is hard, light, fairly close-grained, strong but not tough, and rather pitchy. The heartwood is reddish brown, the sapwood light in color or almost white. It is used for the framework of houses, for bridges, for lagging and studding in mines, and for interior finish. For the latter purpose the sapwood furnishes white satiny boards which are scarcely equalled for the purpose by any other West American tree. The smaller size saw-logs often have a very small heart. Such logs furnish clear boards of high quality which are sometimes difficult to distinguish from Sugar Pine. If there is any doubt at the sorting piles in the yards the boards go as Sugar Pine and are marketed as such. In general, however, an expert will distinguish Yellow Pine from Sugar Pine by its harder wood and coarser grain. Sugar Pine knots are bordered by a black ring. "Apple Pine" is a lumberman's variety of Yellow Pine which furnishes a wood of high commercial quality and marked fragrance.

To the lumbering interests the Yellow Pine is the most important tree in California next to the Redwood. In the general market the sawmill product is always sold under the name of California White Pine, or sometimes as Tahoe Pine. This is because of the prejudice against the common name Yellow Pine, which more properly belongs to a species of the southern United States and has a poor reputation for the quality of its wood. For the same reason the Western Yellow Pine in Arizona is sold under the name of Arizona White

Pine and Navajo White Pine, and in New Mexico under the name of New Mexico White Pine.

During the Civil War the Yellow Pine trunks in the northern Sierras were tapped for their pitch, which was distilled into turpentine and rosin. The turpentine was of good quality and the yield about three or four gallons to each tree. Trees were tapped on two sides only, tapping on three sides killing the tree. With the revival of the southern naval stores industry the local manufacture ceased.

The average age of Yellow Pine in mature stands in the Sierra Nevada is 250 to 350 years, according to Sudworth, although the longevity of occasional trees may reach 500 to 520 years. Reproduction in this species is abundant and persistent. Great quantities of seed are produced, the "seed years" being every other year or falling in succession for two or three years. The seedlings withstand dryness and direct sunlight better than the associated pines and firs. The result is that dense young groves or natural plantations are now characteristic features in the scenery of many portions of the Sierra Nevada, particularly of the mining districts, where the primitive forest was cut away in early days.

The Yellow Pine is the most abundant and widely distributed tree of the forests of California and is particularly characteristic of the Sierra Nevada, where it attains its finest development. The largest trees most commonly grow along the ridges and it is the ridges which the trails ordinarily follow. Here the traveler may journey day after day, over needle-carpeted or grassy ground, mostly free of underbrush, amidst great clean shafts forty to one hundred and fifty feet high, of really massive proportions but giving a sense of lightness by reason of their color, symmetry, and great height. No two trunks in detail of bark are modeled exactly alike, for each has its own particular finish; so it is that the eye never wearies of the fascination of the Yellow Pine but travels contentedly from trunk to trunk and wanders satisfyingly up and down their splendid columns—the finest of any pine.

### 7*a*. **Pinus ponderosa** var. **Jeffreyi** Vasey.

JEFFREY PINE.

Plates 21, 22.

PINUS PONDEROSA var. JEFFREYI Vasey, Rep. U. S. Com. Agr., p. 179 (1875); Engelmann in Bot. Cal., vol. 2, p. 126 (1880); Veitch, Man. Conif., p. 364 (1900); Sargent, Silva N. Am., vol. 11, p. 79, pls. 562, 563 (1897).

*Pinus Jeffreyi* Balfour, Rep. Oreg. Exped., no. 2, t. 1 (1853); Gordon, Pinetum, p. 198 (1858); Lemmon, 2d Rep. Cal. Board For., p. 99 (1888); Coville, Bot. Death Val., p. 222 (1893); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), p. 524 (1900); Leiberg, U. S. Geol. Sur. —For. Cond. Northern Sierra Nevada, p. 26 (1902).

Forest tree 60 to 125 or 170 feet high with yellowish or wine-colored trunks, the bark broken into roughish plates; ordinarily distinguished from the Yellow Pine by its larger, denser cones, which are 5 to 10 inches long and shaped when open like an old-fashioned straw hive; prickle of the umbo often more slender; seeds often obovate, 5 to 7 lines long with a wing 12 or 13 lines long; cotyledons 7 to 13.

The Jeffrey Pine, which merges insensibly into the Yellow Pine, is in its typical form found at high elevations, ranging from 6000 to 9000 feet. It inhabits the San Bernardino and San Jacinto mountains, Sierra Nevada, Mount Shasta, Siskiyou and Scott mountains and the Yollo Bolly Range. Growing at higher altitudes than the Yellow Pine it forms thinner forests, is often flat-topped or broken, and has a greater trunk diameter relatively to its height. It is most abundant and reaches its greatest development on the eastern slope of the Sierra Nevada mountains. The southernmost locality is on Mt. San Pedro Martir in Lower California. The northernmost locality is in Douglas County, Oregon. It was first collected by John Jeffrey, collector to the Oregon Botanical Association of Edinburgh, in Shasta Valley, northern California, October 24, 1852.

By some writers this variety is regarded as a species. While the typical form is clearly to be recognized, it is to be said on the contrary that Jeffrey Pine not only passes over into Yellow Pine, but that the transition forms in the intermediate region are quite as numerous and occupy as extensive an area as the true Jeffrey Pine itself.

### 8. **Pinus Murrayana** Balf.

TAMRAC PINE.

Plate 20, figs. 5, 6; plates 5, 8, 23.

PINUS MURRAYANA Balfour, Rep. Oreg. Exped., p. 2, t. 3 (1853); Lemmon, 2d Rep. Cal. Board For., p. 92, t. 10 (1888); Sargent, Silva N. Am., vol. 11, p. 91 (1897); Merriam, Biol. Sur. Mt. Shasta, p. 38 (1899); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 536 (1900); Hall, Univ. Cal. Publ. Bot., vol. 1, p. 23 (1902); Leiberg, U. S. Geol. Sur.—For. Cond. North. Sierra Nevada, pp. 25, 35 (1902).

*Pinus contorta* var. *Murrayana* Engelmann, Bot. Cal., vol. 2, p. 126 (1880); Veitch, Man. Conif., p. 324 (1900); Jepson, Fl. W. Mid. Cal., p. 23 (1901).

TAMARACK PINE, Jepson, Sierra Club Bull., vol. 4, p. 208, pl. 74 (1903).

Forest tree of symmetrical habit, commonly 50 to 80, but sometimes 125 feet high, or when stunted but a few feet high; bark remarkably thin, rarely more than ¼ inch thick, light gray in color, very smooth but flaking into small thin scales; needles 2 in a sheath, 1½ to 2¾ inches long; staminate catkins 4 or 5 lines long, yellow, 15 to 60 in spike-like clusters; ovulate catkins 2 or 3 lines long, borne chiefly in whorls of 2; cones chestnut brown, 1 to 1¾ inches long,

oblong, but more or less globose when open, falling rather promptly; scales thickened at the ends, black-banded at their tips inside, and with a central umbo prolonged into a slender sub-persistent prickle; seeds 2 lines long, the wing broadly oblong, 5 or 6 lines long; cotyledons 4 or 5.

The Tamrac Pine, commonly called Tamrac and everywhere readily recognized by its two needles, bur-like cones and very thin bark, inhabits the Sierra Nevada from 7000 to 11,000 feet altitude, ranging south to the summits of the San Jacinto and San Bernardino ranges, north to Mt. Shasta, westward to the Siskiyous and Marble Mountain, far north to Alaska and eastward through the whole of the Rocky Mountain region in the United States. The southernmost locality is Mt. San Pedro Martir in Lower California.

In California it is most abundant in swampy Sierra meadows at 6000 to 8000 feet altitude, where it forms pure colonies.[3] On drier slopes and plateaus it is mingled with Red Fir and Mountain Pine. It ranges upward to 9000 and even 11,000 feet, where it is a timber line tree. In these high exposed altitudes it is deformed or stunted or even found hugging close to the bare granite on which it grows.

The wood is light, soft, clean and straight-grained, but perishes quickly in contact with soil and has been hitherto ignored by the lumberman. Subjected to preservative treatments it is coming into use for railway ties, and as high-priced timbers become scarce its field of usefulness will undoubtedly be widened. Young slender trees were always used by the northern Indians for the tepee or lodge-poles, while the large trunks from the dense stands of pure groves are so straight, even-girthed, and uniform that they were a favorite resource for log cabins. The inner bark, especially of young trees, is a winter food of porcupines in the high Sierras.

The Tamrac Pine is by many authors treated as a variety of the Beach Pine of the coast. These two species do undoubtedly grade into each other in those limited places where they meet in the north. On the contrary, the typical forms of the two are not only very distinct and their general habitats widely different, but the typical form is in each case the only form throughout the main geographical region of that species.

*Pinus Murrayana* was found by John Jeffrey, collector to the Oregon Botanical Association of Edinburgh, in northern California in 1852. His label on the specimen preserved in the Herbarium of the Royal Botanic Garden at Edinburgh reads thus: "Found on the Siskiyou Mountains in Lat. 43° 30′. Elevation 7500 feet. Growing on moist deep loamy soil, Oct. 21. Tree 40 feet high, of a conical form." He collected the same species again on the "Summit of the Sierra Nevada Mountains near Walker's Pass, Sept. 20, 1853." It was named

[3] Illustrated in plate 23.

for Andrew Murray, of Edinburgh, Secretary of the Association which sent Jeffrey to Oregon and California.

It is also called Murray Pine, Pitch Pine, and, in the Uinta Mountains of Utah, Red Pine. In the Rocky Mountains it is universally known as Lodgepole Pine, a name far preferable to the unfortunate folk-name, "Tamrac," accepted in California, since the latter suffers confusion with the true Tamarack or eastern Larch.

### 9. **Pinus contorta** Don.

BEACH PINE.

Plate 20, figs. 3, 4.

PINUS CONTORTA Loudon, Arb. Britt., vol. 4, p. 2292, figs. 2210, 2211 (1838); Gordon, Pinetum, p. 165 (1858); Engelmann, Bot. Cal., vol. 2, p. 126 (1880); Lemmon, Erythea, vol. 2, p. 174 (1894); Sargent, Silva N. Am., vol. 11, p. 89, t. 567 (1897); Veitch, Man. Conif., p. 323 (1900); Jepson, Fl. W. Mid. Cal., p. 23 (1901).

Scrub pine 2 to 35 feet high, commonly with depressed or irregular dark green crown, the trunk mostly ¼ to 1¼ feet in diameter, and vested in dark rough bark; needles 2 in a sheath, 1¼ to 2 inches long, clothing the branchlets densely, and persisting 2 or 3 years; staminate catkins 20 to 65 in a spike-like cluster, conical, 3 to 4 lines long; ovulate catkins red, borne 1, 2, or 3 in a circle at the end of the branchlet just below the terminal bud, about 2 lines long; cones when closed narrowly ovate or sub-cylindric, somewhat oblique, spreading or eventually declined, 1¼ to 1¾ inches long, releasing their seeds when fully mature, falling after 4 or 5 years or remaining on the tree many years; exposed part of the scale slightly raised (low pyramidal) and bearing a very slender prickle which weathers away in age; seed 1½ to 2 lines long, with a wing 3 to 6 lines long; cotyledons 4 or 5.

The Beach Pine, in typical form, inhabits the sand-dunes and bluffs on the shores of the ocean and is also called Shore Pine, Scrub Pine, Twisted-branch Pine, and Knotty Pine. The southernmost locality is on the ocean bluffs at Elk in southern Mendocino; thence it ranges northward along the coast to southeastern Alaska, and also extends eastward in the mountains of southern Oregon, passing by slight gradations into forms which cannot be distinguished from the Tamrac or Lodgepole Pine. On the sand-dunes and bluffs it is dwarfed, distorted or of irregular growth by reason of the exceedingly exposed situations which it occupies. The weave of its foliage and branchlets to windward is often remarkably close and uniform, making to leeward completely sheltered nests where the wayfarer may take refuge against the cold winds driving in from the Pacific Ocean. Such trees protect others of their kind further inland, some of the latter thereby attaining a height of forty feet.

On the singular Mendocino "White Plains," a strip of mesa-like land strongly impregnated with alkaline salts, lying one to six miles from the coast at Fort Bragg and Mendocino City, grows a dwarf form of this species. The trees are three to fifteen feet high, regular and symmetrical in their growth, and betraying no sign of age except in their abundant crops of cones. This form was long ago collected by Bolander, botanist of the California Geological Survey, and named *Pinus Bolanderi* by Parlatore (DeCandolle, Prodr., vol. 16, pt. 2, p. 379).

Of slight economic value for its wood, since the trunks are small and faulty, it is of great importance in the natural reclamation of the sand-dunes on the coast of Oregon and Washington, where it forms low-headed trees whose lower limbs lie prostrate as a protection to the uneasy sands. The cones are borne most prolifically, every tree being full of them. To the traveller the Beach Pine is always an interesting feature of the north coast, because the form of the tree is so frequently an expression or record of its battle with the elements, and while of insignificant stature it often attains a dignified age, its maximum longevity being two hundred and seventy-five and possibly three hundred years.

### 10. **Pinus Coulteri** Don.

BIG-CONE PINE.

Plate 24; plate 25, fig. 5.

PINUS COULTERI Don, Trans. Linn. Soc., vol. 17, p. 440 (1837); Loudon, Arb. Britt., vol. 4, p. 2250, figs. 2144-2147 (1838); Bolander, Proc. Cal. Acad., vol. 3, p. 318 (1867); Engelmann, Bot. Cal., vol. 2, p. 127 (1880); Kellogg, For. Trees Cal., p. 48 (1882); Lemmon, 2d Rep. Cal. Board For., p. 103, t. 13 (1888); Leiberg, 20th Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 422, 443 (1900); Veitch, Man. Conif., 325 (1900); Sargent, Silva N. Am., vol. 11, p. 99, t. 571, 572 (1897); Jepson, Fl. W. Mid. Cal., p. 21 (1901); Hall, Univ. Cal. Publ. Bot., vol. 1, p. 20 (1902).

*Pinus macrocarpa* Lindley, Bot. Reg., vol. 26, Misc. p. 62 (1840); Hartweg, Jour. Lond. Hort. Soc., vol. 2, p. 188 (1847), vol. 3, p. 227 (1848); Gordon, Pinetum, p. 201 (1858).

*Pinus Sabiniana* Parry, Bot. Mex. Bound., p. 210 (1859), as to San Diego station, not of Don.

Tree commonly 40 to 75 or even 90 feet high, with conical or more often spreading habit, long lower branches, yellowish green foliage and trunks 1 to 2½ feet in diameter; bark dark, roughly broken so as to form an irregular network of longitudinal fissures and sometimes loosening superficially into large thinnish scales; needles in 3s, erect, tipped with a short hard point, 5 to 10 (or 14) inches long; staminate catkins 15 to 65 in a cluster, at first ovoid, at length cylindric and 1 inch long; ovulate catkins borne in circles of 3 to 5; cones broadly ovoid, 10 to 13 inches long and 5 to 7½ inches thick, when falling breaking through near the base like the cone of Yellow Pine; scales with the umbos drawn out into prominent tusk-like points or spurs which towards the

base of the cone on the outer side are developed into curving talon-like appendages; seeds nearly black, 6 to 8 lines long; wing reddish brown, 12 to 15 lines long, 6 to 7 lines wide, strongly thickened at base and carried around the seed as a narrow rim; cotyledons 9 to 17.[4]

The Big-cone Pine inhabits dry mountain sides and is distributed from the San Bernardino Range southward to the Cuyamaca Mountains[5] and northward through the Coast Ranges to the Santa Lucia Mountains and San Carlos and Mt. Hamilton ranges. It forms a scattered growth or thin forest and in its most abundant development occurs at lower altitudes than the Yellow Pine, although often freely scattered through the lower portion of the Yellow Pine belt. On Mt. San Jacinto it is most common along the lower edge of the Yellow Pine zone between 4000 and 5000 feet, but ranges as high as 6500 feet, and it is widely distributed on the San Bernardino and San Gabriel mountains, where it begins at 3000 to 4000 feet and stops at 6500 feet.

In the Santa Lucia Mountains it is a frequent tree and is found on both the eastward and seaward slopes. The San Antonio trail crosses that range to the south of Santa Lucia Peak; the eastern end of the trail begins only a few miles from Mission San Antonio and on the west side it dips down into the Cañada Honda. Big-cone Pine occurs abundantly on the east slope above the Digger Pine; it is also encountered on the western slope near the summit, associated with Sugar Pine. This is doubtless the locality where first collected by Dr. Thomas Coulter in 1831, who found it "on the mountains of Santa Lucia near the mission of San Antonio, in latitude 36°, within sight of the sea and at an elevation of from 3000 to 4000 feet above its level. It was growing intermingled with *Pinus Lambertiana.*" Groves of Santa Lucia Fir are not far distant. Lower down the western slope is a Yellow Pine belt, noted on my journey of 1901. It would appear that the usual altitudinal relation of the Yellow Pine and Big-cone Pine may here be reversed on account of local conditions.

In the Big Sur country of the Santa Lucias, thirty miles north of the San Antonio Trail, one may find about Cold Spring the Big-cone Pine in three very unlike situations within the space of a mile: (1) Growing thirty to fifty feet high, it mingles with the Yellow Pine which colonizes the moister slopes at the summits of ridges at about 2200 feet altitude. (2) It is found as scattered trees on the exposed and abrupt western slopes which run down into sharp cañons cutting to the sea with impressive directness; within one hundred yards of these trees on the slopes Redwoods stand in narrow files in the bottoms of the

[4] The maximum number is attested by seed from Mt. Diablo which shows 15 to 17 cotyledons. The minimum number is on the authority of Sudworth (For. Trees Pac. Slope, p. 57).

[5] This species grows in Pine Valley, San Diego County (acc. C. N. Forbes). These are the trees mistaken by Parry for Digger Pine (Bot. Mex. Bound., p. 210).

cañons. (3) Finally, it recurs a short distance eastward as scattered sentries on the driest and rockiest chaparral slopes, where it is associated with Knob-cone Pine, grows ten to sixteen feet high, and begins to bear cones when fourteen years old.

In the San Carlos Range, Big-Cone Pine occurs between 3000 and 4900 feet and is the dominant species. The original stand has been almost entirely cut away, but reproduction is fairly abundant owing to the early age at which the trees produce cones. The northernmost locality is Mt. Diablo, where it is found on the lower north slopes not far from the village of Clayton.[6] It has also been reported from the Mount Hamilton Range, where it occurs on the high ridges easterly from the Lick Observatory.

The Big-cone Pine is most remarkable for its large cones, the most massive borne by any pine, and for their talon-like appendages. In the character of the cones, their form and scale processes, and contained seeds, near relationship to the Digger Pine is clearly exhibited, although in its general habit, unbranched axis and erect needles it closely resembles the "Bull Pine" or "Jack Pine" forms of the Yellow Pine. Its pale or yellowish green foliage is, however, always readily distinguishable from the bright green masses of Yellow Pine leaves.

As a timber tree it is of slight importance. On account of its scattered or at least thin growth the shafts retain their lower limbs and do not form good clear logs. Moreover, the wood is very resinous, very brittle, warps with great facility and in consequence is never used for lumber except in those localities where good timber is scarce. Near Julian in San Diego County it is used for timbering in the Stonewall Mine. In Southern California the tree is of most economic importance as a ground cover on arid slopes where other species will not grow. It is one of the "Nut Pines," but the nuts were either not harvested by the native tribes of the region or only when they could not procure the nuts of the One-leaf Piñon, which they much preferred.

### 11. **Pinus Sabiniana** Dougl.

DIGGER PINE.

Plate 25, figs. 1-4; plate 26.

PINUS SABINIANA Douglas, Trans. Linn. Soc.; vol. 16, p. 747 (1833); Loudon, Arb. Britt., vol. 4, p. 2246, with figs. (1838); Hartweg, Jour. Hort. Soc. Lond., vol. 2, p. 188 (1847); Gordon, Pinetum, p. 208 (1858); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 37 (1857); Engelmann, Bot. Wheeler, p. 375 (1878); Kellogg, For. Trees Cal., p. 45 (1881); Lemmon, 2d Rep. Cal. Board

[6] Lemmon has named the Mt. Diablo trees as Var. *diabloensis* (Bull. Sierra Club, vol. 4, p. 130, 1902), distinguished chiefly by the short wings to the seeds. Seeds from these trees at Clayton, the only Big-cone Pines known to us as occurring on the mountain, have wings as long as is usual in the species. It is possible that the author of this variety may have mixed with his *Pinus Coulteri* material the strongly spurred cones of the Mt. Diablo variety of *Pinus Sabiniana*, the seeds of which bear exceptionally long wings.

For., p. 105, pl. 14 (1888); Coville, Bot. Death Val. Exped., p. 223 (1893); Davidson, Erythea, vol. 3, p. 156 (1895); Sargent, Silva N. Am., vol. 11, p. 95, pls. 569, 570 (1897); Veitch, Man. Conif., p. 375 (1900); Sudworth, 21st Rep. U. S. Geol. Surv., pt. 5 (For. Res.), p. 516 (1900); Jepson, Fl. W. Mid. Cal., p. 22 (1901).

Var. EXPLICATA Jepson, Trees Cal., p. 217 (1909).

DIGGER PINE, Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, pp. 27, 28 (1902).

NUT PINE, Powers, Proc. Cal. Acad., vol. 5, p. 374 (1874).

Singular pine 40 to 50 or occasionally 90 feet high, with open crown and thin gray foliage; trunk 1 to 4 feet in diameter, frequently slanting, in typical trees branching at 5 to 15 feet from the ground into a cluster of slender erect branches which form a broom-like top; needles in drooping clusters of 3s, 7 to 13½ inches long; staminate catkins at first ovoid and 6 or 7 lines long, soon becoming cylindric and 1½ times as long, 8 to 21 in spike-like clusters; ovulate catkins ½ inch long, solitary or most commonly 2 or 3 in a circle (the circles sometimes 2 on a shoot), borne on erect stalks 2 to 2½ inches long; one-year-old cones ovoid-globose, about 2 inches long, on recurved stalks, with the basal scales more or less free and recurved-spreading or deflexed; mature cones subglobose when open, 6 to 10 inches long, 5 to 7 inches broad and only slightly unsymmetrical, remaining on the tree 1 to 7 years after releasing their seeds; when falling breaking through near the base and leaving the basal portion on the limb ("broken-cone" type); tips of the scales strongly developed into triangular hooks projecting downwards, about 1 inch long; seeds oblong in outline, slightly flattened, and slightly ridged towards the micropyle, 9 to 11 lines long, 4 or 5 lines wide, bearing an oblique wing 3 to 5 lines long and ½ inch broad; shell hard, covered with a thin black coat which is eventually more or less deciduous; cotyledons 11 to 17.

The Digger Pine inhabits the arid foothills of the Sierra Nevada and Coast Ranges surrounding the oval of the Great Valley of the Sacramento and San Joaquin, save for a curious break of twenty or twenty-five miles either side the Kaweah River in the southern Sierra Nevada between Kings River and White River. It is also generally distributed throughout the dry valleys and hills of the North Coast Ranges as far westward as the borders of the Redwood Belt. In the South Coast Ranges it is common in the Mt. Diablo, Mt. Hamilton and San Carlos ranges, eastern slope of the Santa Cruz and Santa Lucia mountains, thence extends southward to the Mt. Pinos region in Ventura County, and finally to the Sierra de la Liebre south of Tehachapi and Antelope Valley, the southernmost locality.

It is attributed to the "mountains east of San Diego" in the Botany of the Mexican Boundary Survey, doubtless a mistaken identification of the Big-cone Pine. In any event the Digger Pine has not since been found in that region and it may be remembered that Parry was sometimes in error about his localities as

evidenced by such cases as his San Diego station for *Thuja gigantea* on page 211 of the above work.

In the Sierra foothills it was and is still in certain districts common at an altitude of 800 to 2000 feet. In this belt it is the only pine except at the upper limits of its distribution, where it may meet the Yellow Pine or even in scattered places thrust narrow tongues a short distance into the Yellow Pine belt proper. It is, again, commonly the only pine in the inner Coast Range where in many places, as on Mt. Diablo, it is very abundant. In the Santa Cruz Mountains, in the Mt. St. Helena Range and in other ranges it is inclined to follow the outcropping ledges on mountain sides or secondary ridges, and even where common showing a disposition to keep to itself, although sometimes mixing with Douglas Fir in the hills and with Yellow Pine on the floors of gravelly valleys.

The species attains its highest development in the upper Sacramento Valley, especially in the Cottonwood Creek district lying between the upper Sacramento River, and the inner Coast Range, where the largest and tallest trees are found. That rolling country possesses a remarkable sameness in that the rounded hills are everywhere of the same height, everywhere composed of gravel-loaded clays, soft enough in the rainy season but hardening like cement in summer, and everywhere exhibiting the same sort of vegetation, Manzanita, Blue Oak and Digger Pine. Destitute of prominent landmarks or vantage points, those low hills and the maze of dry water courses are hopelessly confusing on a cloudy day but for the Digger Pines, which often form massive and very individual figures on the hill-tops or on the gravelly benches of the winter streams. Northward as far as the neighborhood of Redding the trees are so abundant as to form a very open but extensive forest.

The most northerly locality at which I have found it is in that portion of the very rugged and rocky gorge of the South Fork of the Salmon River between Cecilville and Bennet, where the cañon cleft is narrow and the baking heat intense in the rainless season. The trees are common here on the south slope, forming a marked zone; they mostly favor the ragged rocky spurs which fall off to the river bottom from the mountain side and their figures stand against the sky as the traveler sees them from the river trail.

Altitudinally the Digger Pine is most common between 600 and 2000 feet, but ranges as high as 3000 feet in the central Sierra Nevada, to 4600 feet at Tehachapi and as low as 250 feet above sea-level on the floor of Napa Valley near St. Helena. In the San Carlos Range it is everywhere associated with Coulter Pine, Yellow Pine and Incense Cedar, its stragglers even ascending to the summit of San Benito Peak, 4900 feet.

Summing up the facts of its distribution, two points of interest may be noted: First, we have here a coniferous species confined to the Coast Ranges and the western slope of the Sierra Nevada, that is, to California in the biological sense, but exceedingly well distributed. In this respect it is comparable

with the Knob-cone Pine, California Buckeye and Blue Oak. Second, it is throughout its range found under seemingly uniform climatic conditions, although showing a marked preference for the serpentine rocks even where the rainfall is above its assumed optimum.

In structure Digger Pine shows on the whole slight variation. There are, however, two cone forms, one in which the spurs point straight down, the other in which they are more or less curved at tip. A strongly spur-hooked form is found towards the head of Mitchell Cañon, Mt. Diablo, and has been named var. EXPLICATA by the author (Trees Cal., p. 217). This variety has seeds in which the wing is six lines long and in this particular differ slightly from the typical form.

In habit *Pinus Sabiniana* is more variable. While often erect the leaning habit is so common and so marked that this character is a feature as strongly associated with this species as the branching axis and open habit. The mode of growth of the branches and their varying divergence give rise to widely unlike types of crown. Sometimes there may be only two or three branches instead of seven or twenty, rarely the trunk may be unbranched for forty or fifty feet and melt into a roundish crown. The "broom" type of tree is shown in plate 26.

Digger Pines make their most rapid growth in height between five and twenty-five years of age, and more especially between twelve and sixteen years. The age of the oldest trees is 175 years according to Leiberg. Cone-bearing begins early, when the trees are twelve to fourteen years of age. Reproduction is amply provided for, as the tree grows older, by the production of great quantities of cones. Second growth is fairly common, even in pasture lands, and the species may be said to reproduce itself with fair persistence. Young trees, fifteen or twenty feet high, cultivated in the interior valleys, are beautiful and striking objects on account of their vigorous growth and abundant gray-green foliage. As a decorative feature of interior gardens its possibilities have not hitherto been appreciated. It was introduced into Kew Gardens by Douglas in 1832, but has not done well in the English climate.

The wood of the Digger Pine is coarse-grained, not strong and exceedingly pitchy; when seasoned it is very hard and flinty. It has been largely used for fuel, makes a remarkably hot fire, and is consumed in great quantities by the hoisting engines at quartz mines in the Sierra Nevada. Sometimes it is used for mine props in the stopes, but rots very quickly when wet, rarely lasting more than six months. In regions where timber is scarce it has been utilized in construction, although it makes an unsatisfactory lumber when sawn, on account of its faculty for warping. The woodsmen say with humorous exaggeration "Boards from the mill stacked outside to season will walk off the lot over night." Like the Yellow Pine it varies remarkably in timber quality and selected trees have been known to yield a strong tough wood. It is said that the

pitch cannot be converted into turpentine, but it is used as the base of a perfume and detergent called "abietine."

This species is one of the "nut pines." The "nuts" or seeds were a favorite article of food with the native tribes and they had no more useful tree save the oaks. It is small wonder then that the Indian looked on in distress whenever the "white man" cut down a Digger Pine. The green cones were, also, an article of food with native tribes, who removed the soft core in June and ate it uncooked; they also ate the young buds and the inner bark in the spring, according to Powers, when food was scarce.

Digger Pine is the familiar white man's name for the species and its origin is clear to those who know that "Digger" is his opprobious and impartial designation of all native tribesmen. The name Squaw Pine is less commonly used and has a similar origin, but pays tribute to the women who harvested the winter's store of nuts. Gray Pine, Gray-leaf Pine, and Blue Pine are names which interpret the hue of the foliage. Bull Pine is also in local use, a name indiscriminately applied by woodsmen to any economically inferior species or local variety, while Hooked Bull Pine is a variant of this. Newberry wrote in 1855 that it is sometimes called "Wythe Pine" on account of the toughness of the wood.

Sabine Pine as a common name is frequent in the literature. *Pinus Sabiniana* was dedicated to Joseph Sabine, Secretary of the London Horticultural Society by David Douglas. Douglas discovered the tree during his travels in the California Coast Ranges in 1830 and 1831 and sent a paper home describing this new species, which was published in the Transactions of the Linnean Society of London for 1833 (vol. 16, p. 747). It was dated at San Juan Mission, Upper California, February 4, 1831, but there is nothing to indicate from what particular locality he had his material.[7] His travels must have made him well acquainted with the tree in its native habitats, yet his communication is not exact and makes no mention of the tree's most striking features. In the paper just cited he makes the statement that he had previously seen this species south of the Columbia River in "northern California," *i.e.*, what is now southern Oregon. Even before I had noticed this statement, reports of a tree presumed to be Digger Pine or Coulter Pine came to me from that region but have never been verified by specimens.

Scarcely in any sense a beautiful tree, offering no comfort of shade to the inexperienced wayfarer who, dusty and sun-bitten, seeks its protection, scorned, too, by the lumbermen, it is nevertheless the most interesting and picturesque tree of the foothills on account of its scattered growth, its thin gray cloud of foliage, its variety of branching and its burden of massive cones.

[7] *Pinus Sabiniana* grows in the Gabilan Range, at the easterly foot of which lies the old mission of San Juan Bautista. Douglas, doubtless, collected his material on the Gabilan.

## 12. **Pinus Torreyana** Parry.

### Torrey Pine.

Plate 27, figs. 1, 3.

Pinus Torreyana Parry, in Bot. Mex. Bound., p. 210, pls. 58, 59 (1859); Engelmann, Bot. Cal., vol. 2, p. 125 (1880); Lemmon, 2d Rep. Cal. Board For., p. 106, t. (1888); Sargent, Silva N. Am., vol. 11, p. 71, pls. 557, 558 (1897); Veitch, Man. Conif., p. 348 (1900); Angier, Overland Monthly, ser. 2, vol. 35, p. 492 (1900).

Small tree, commonly 15 to 20 feet high, the older trees with widely spreading branches forming an unsymmetrical crown; trunks ¾ to 1½ feet in diameter, brown, with fissured scaly bark; foliage in heavy tufts at the ends of the branchlets; needles in 5s, 7 to 10 inches long; staminate catkins cylindrical, 1 to nearly 1¾ inches long, borne in clusters of 5 to 15 in the upper axils of the scale-leaves; cones triangular-oval in outline, 4 to 5½ inches long, of about equal diameter; scales pyramidally thickened at apex with a heavy umbo ending in a minute prickle; seeds oval, compressed or flattened on three sides, 5 to 10 lines long, 3½ to 6 lines broad, with a dark-brown wing 3 to 6 lines long and nearly or quite as broad, the shell thick, hard, usually brown below and sprinkled with minute brown dots on the upper side; cotyledons 11 to 13.

The Torrey Pine, also called the Soledad Pine and Lone Pine, is found only on Santa Rosa Island and on the San Diego coast. On the eastern end of Santa Rosa Island there are about one hundred scattered trees of all sizes up to thirty feet in height. On the San Diego coast hills it grows about the mouth of the Soledad River, near Del Mar, and southward about eight miles towards San Diego, ranging inland about a mile and a half. The trees are scattered or form a very thin growth, confined mostly to the barranca-broken slopes where the mesa falls off to the Soledad River, to sheltered cañons, where trees forty feet high are occasional, or to bluffs overlooking the ocean, where semi-prostrate forms are found.

*Pinus Torreyana* is remarkable for its peculiar cones, its very long needles and especially for its very restricted habitat which has attracted to it a great deal of attention. The trees themselves are, however, disappointing. They are insignificant in stature and habit, and notwithstanding that they are the only trees where they grow they dominate the landscape so little as scarcely to be noticed except by the traveller acquainted with the peculiarities which give them a singular interest.

Under the influence of a different climate and of cultivation the Torrey Pine exhibits at Berkeley a much modified habit. In the Botanic Garden of the University of California is a tree with a perfectly straight axis, symmetrical crown and regular whorls of branches, about seventeen years old,[8] which

[8] In 1908.

shows a total height of 30¾ feet. It has been moved three times, the last time about thirteen years ago, but has grown rapidly since. During each of the years 1905, 1904 and 1903 it grew 4 feet; in 1902 it grew 2½ feet; in 1901, 1⅔ feet; in 1900, 2½ feet; in 1899, 4 feet, and in 1898, 2¾ feet. In October, 1908, the trunk was 3 feet 9½ inches in circumference at two feet above the ground. In the autumn an exceptionally large bud is formed at the tip of the main axis. In the winter season of 1904-5 this bud was about one foot in length, for three months remaining about the same size until starting into active growth in March.

The trees growing in the San Diego County locality, the first to be made known, were discovered by Dr. C. C. Parry, botanist of the Mexican Boundary Survey, and named in honor of Professor John Torrey of Columbia College, long a student of western plants and a visitor to California before the days of the overland railroad.

### 13. **Pinus Parryana** Engelm.

PARRY PINON.

PINUS PARRYANA Engelmann, Am. Jour. Sci., ser. 2, vol. 34, p. 332 (1862), not Gordon; Bot. Cal., vol. 2, p. 124 (1880); Kellogg, For. Trees Cal., p. 41 (1882); Lemmon, 2d Rep. Cal. Board For., p. 89, pl. 8 (1888); Orcutt, Gard. & For., vol. 5, p. 183 (1892); Parish, Zoe, vol. 4, p. 350 (1894), Erythea, vol. 7, p. 89 (1899).

*Pinus quadrifolia* Parry ex Parlatore in DeCandolle, Prodromus, vol. 16, part 2, p. 402 (1868); Sudworth, U. S. Div. For. Bull., no. 14, p. 17 (1897); Sargent, Silva N. Am., vol. 11, p. 43. t. 549 (1897).

*Pinus Llaveana* Torrey, Bot. Mex. Bound. Sur., p. 208, pl. 53 (1859) not Schlectendahl.

Low tree with round-headed crown, 15 to 35 feet high, the trunk ½ to 1 foot in diameter; needles slate-colored on the upper side, white glaucous below, ¾ to 1¾ inches long, borne in 2s, 3s, 4s, or 5s, the latter being commonest toward the top, the 3-leaved on the lower branches; staminate catkins 2 or 3 lines long, 15 to 25 in spike-like clusters; ovulate catkins borne 1 or 2 in a place on stalks ¼ to ½ inch long; cones subglobose, 1¼ to 2 inches long; scale tips developed into stout pyramids with shrunken umbos; seeds partly sunken, obovate, 8 lines long, with thin shell; cotyledons 6 to 8.

The Parry Piñon inhabits the dry mountains of Lower California from San Pedro Martir northward into Southern California. Its region of greatest development is in northern Lower California where, according to Orcutt, an extensive but thin and broken forest about thirty miles wide and fifty miles long extends over the plateaus and mountains from Mt. San Pedro Martir to within a few miles of the California boundary at elevations varying from 3500 to 7000 feet.

In Southern California it is a rare tree, and occurs sparingly. It has been reported from Larkin Station and from near Julian in San Diego County and occurs in considerable numbers on the lower slopes of the Santa Rosa Mountain towards Coyote Cañon between 3000 and 5000 feet. There are also a few trees on the mesa at the base of El Toro between Van Deventer's ranch and the Santa Rosa Indian village, the most northerly station, and a few more on the slope of Nigger Jim Hill.

This is one of the nut pines, the sweet nuts of which are used by the Indians. Its cones are strikingly similar to those of the One-leaf Piñon, *Pinus monophylla.*

### 14. **Pinus monophylla** Torr.

ONE-LEAF PINON.

Plate 27, figs. 2, 4.

PINUS MONOPHYLLA Torrey, in Fremont's Rep. Second Exped., p. 319, pl. 4 (1845); Fremont, Rep. Second Exped., pp. 221, 222, 225, 226, 229 (1845); Bolander, Proc. Cal. Acad., vol. 3, p. 318 (1867); Watson, Bot. King, p. 330 (1871); Rothrock, Bot. Wheeler, p. 259 (1878); Engelmann, Bot. Cal., vol. 2, p. 124 (1880); Lemmon, 2d Rep. Cal. Board For., p. 88 (1888); Jones, Zoe, vol. 3, p. 307 (1893); Merriam, N. Am. Fauna, no. 7, p. 337 (1893); Coville, Bot. Death Val., p. 222 (1893); McClatchie, Erythea, vol. 2, p. 77 (1894); Masters, Ann. Bot., vol. 2, p. 124 (1888); Sargent, Silva N. Am., vol. 11, p. 51, t. 551 (1897); Leiberg, 20th Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 423, 444 (1900).

*Pinus Fremontiana* Endlicher, Syn. Con., p. 183 (1847); Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 293, fig. (1849), Pinetum, p. 194 (1858).

*Pinus Llaveana* Hartweg, Jour. Hort. Soc. Lond., vol. 3, p. 226 (1848), not Schlectendahl.

Most commonly a low round-headed tree 8 to 25 or at the most 45 feet high, the trunk very short; needles 1 in a place, cylindric, curving upward and ending in an abrupt point, 1½ to 2 inches long, persisting 7 or 8 years; staminate catkins dark red; cones subglobose, chocolate-brown or yellow, 2½ to 3½ inches in diameter, scales thick, raised at apex into high broad-based pyramids with slightly umbilicate or flattened summits bearing a minute prickle; seeds dark brown, oblong in outline, slightly flattened, ¾ inch long, without wings; cotyledons 7 to 10.

The One-leaf Piñon, often called Nut Pine, is an inhabitant of the slopes lying immediately above the drought-haunted foothills of the desert mountains of Arizona, southern Utah and Nevada. It extends westward to the desert ranges of California (White, Inyo, Grapevine and Charleston mountains) and to the eastern walls of the Sierra Nevada and the San Jacinto Range. It is widely distributed over southern Nevada and occurs as far north as Steamboat Springs in the Virginia Mountains (*Kennedy*) and East Humboldt Mountains (*Watson*), the latter the most northerly recorded locality.

On the eastern wall of the Sierra Nevada it is common between 4000 and 9000 feet from near Markleeville, Alpine County, to the Cottonwood Trail near Lone Pine and southward. In the southern Sierra Nevada it has in a few places pushed its outposts into mountain passes and gorges still further westward, and is found on Bubbs Creek and on the abrupt western wall of the grand cañon of the Kern River on the trail to Upper Funston Meadow.[9] It grows on both slopes of Walker Pass and the Tehachapi Mountains, where it occurs as low as 3700 feet and ranges westward to Frazier Mountain, where it is found at 7200 feet on the northwest side and to Mt. Pinos where, according to Hall, it forms an encircling belt between 5200 and 6000 feet about the mountain, is not uncommon up to 7000 feet and is represented by a single tree at 8600 feet. It has been seen by Hopping near the Sespe River and is also said to occur in the San Rafael Mountains still further westward. On the desert slope of the San Gabriel and San Bernardino ranges between 3500 and 9500 it is common and often abundant, and passes over the axis of the latter range to the southern slope above 7000 feet. On Mt. San Jacinto it occurs on the eastern wall between 3000 and 6000 feet and ranges south into Lower California.

*Pinus monophylla* was discovered by Captain Fremont on his Oregon-California Expedition of 1844. Traveling southward from the Columbia River through the Great Basin to Pyramid Lake, he finally determined to find a way across the Sierra Nevada mountains to the Sacramento Valley. Reconnoitering for a pass the expedition journeyed south along the east fork of Walker River, and made a circuit westerly to the west fork of Walker River, passing at no great distance from what is now the town of Bridgeport, California. In this region he first met the One-leaf Piñon which he refers to as the Nut Pine: "A man was discovered running toward the camp as we were about to start this morning, who proved to be an Indian of rather advanced age—a sort of forlorn hope, who seemed to have been worked up into the resolution of visiting the strangers who were passing through the country. He seized the hand of the first white man he met as he came up, out of breath, and held on, as if to assure himself of protection. He brought with him in a little skin bag a few pounds of the seeds of a pine tree, which today we saw for the first time, and which Dr. Torrey has described as a new species, under the name of *Pinus monophyllus;* in popular language it might be called the nut pine. We purchased them all from him. The nut is oily, of very agreeable flavor, and must be very nutritious, as it consists the principal subsistence of the tribes among which we are now traveling."

On account of its supplementing the scanty food supply of the company, Fremont continues to note at frequent intervals in the narrative the occurrence

[9] It was also found in Piute Creek near Pate Valley, Grand Cañon of the Tuolumne River, in 1909 by Herbert W. Gleason.

of the Nut Pine as they turned northwesterly, reached again the waters of the Carson River and ascended the Sierra Nevada mountains. Above the limits of this tree the party crossed the chain at or near the later Carson Pass. Fremont saw it again on the edge of the Mohave Desert after passing over Tehachapi Pass on his way to join the Wolfskill Trail to Santa Fé.

The One-leaf Piñon, also called Piñon, Single-leaf Nut Pine, Nevada Nut Pine, Fremont's Nut Pine, One-leaf Pine, grows in the most arid situations of any California pine. On account of its solitary leaves and its low apple-tree habit it scarcely looks like a pine. The wood is light, soft, close-grained and like desert woods in general makes a good fuel. It is also converted into charcoal and is used for timbering in mines. The Indians gather the cones in quantity, often several burden baskets from one tree, for the sake of the edible nut-like seeds, the kernel of which is very sweet and very nutritious and preferred to those of any other nut pine because more farinaceous and less oily. The men beat off the cones with long poles, while the women gather them into piles and set them on fire, after which the seeds are easily separated from the charred remains, placed in the burden baskets and carried to the village. For many tribes the Nut Pine crop was a main reliance, and long before the white man came the seeds were an article of commerce on the Indian trade routes. Hartweg records that they were offered for sale at Mission Santa Inez in 1847.

### 15. **Pinus muricata** Don.

BISHOP PINE.

Plate 28, figs. 1, 2; plates 13, 29.

PINUS MURICATA Don, Trans. Linn. Soc., vol. 17, p. 441 (1837); Hooker & Arnott, Bot. Beechey, p. 393 (1842); Lindley, Veg. King., p. 229*a*, fig. 158*a* (1853); Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 216, t. (1849); Torrey, Bot. Mex. Bound., p. 209, pl. 54 (1859); Gordon, Pinetum, p. 173 (1858); Engelmann, in Bot. Cal., vol. 2, p. 128 (1880); Lemmon, 2d Rep. Cal. Board For., p. 118 (1888); Purdy, Gard. & For., vol. 9, p. 242 (1896); Sargent, Silva N. Am., vol. 11, p. 139, tt. 585, 586 (1897); Veitch, Man. Conif., p. 351 (1900); Jepson, Fl. W. Mid. Cal., p. 23 (1901); Matthews, Tree Cult. New Zealand, p. 117, pl. 26 (1905).

*Pinus contorta* Bolander, Proc. Cal. Acad., ser. 1, vol. 3, p. 227 (1866), not of Loudon.

Littoral tree 40 to 80 feet high with trunk 1 to 3 feet in diameter, the axis and branches with persistent circles of cones from near the base to the summit; bark 1 to 1½ inches thick, dark red, brown on the surface, soft and brittle, broken by fissures into rough ridges; needles 2 in a sheath, flat on the under surface, round above, 4 to 6 inches long, borne in rather dense tufts at the ends of the branchlets and persistent 2 or 3 years; staminate catkins ovate, 3 or 4 lines long, 12 to 60 in a cluster, their stipes exserted from the winter bud; cones broadly ovate, acute, 2 to 3 inches long, almost as broad, or when open more or less globose, borne on the tree in circles of 3, 4, or 5, gradually turned down-

ward, developed more strongly on the outside towards the base and in consequence always one-sided; exposed part of the scale rhomboidal, bearing a central prickle with a broad base, or in the case of the highly developed scales the parts stand out as very stout straightish or upwardly curving spurs; seeds black, sometimes mottled, the thin shell minutely roughened on the surface, 2½ to 3 lines long, with pointed lower end, the apical end obliquely truncate; wing broadest above the middle, oblique at summit, 5 to 8 lines long and 2½ to 3½ lines broad; cotyledons 4 to 7.

The Bishop Pine grows on flats or on low hills bordering or near the sea, rarely ranging more than two or three miles inland. It is distributed from Mendocino County southward to San Luis Obispo, again appearing in a modified form in Lower California and on Cedros Island. While, therefore, confined to a long and narrow strip of sea-coast its extended range is in the main made up of disconnected localities and there is, furthermore, a marked difference between its occurrence north and its occurrence south of San Francisco Bay. North of San Francisco Bay the strip is almost continuous from Inglenook in Mendocino County southward to Bear Valley on the Point Reyes Peninsula. The groves of the Mendocino coast flats, where the species reaches its best development in height, extend from Inglenook southward to Mendocino City. It also occurs on the so-called "White Plains" of Mendocino County in a low form. Thence along the ocean bluffs there occur scattered trees connecting with the fine groves distributed over the low hills from Point Arena in Mendocino County to Stewarts Point in Sonoma County. Between the latter locality and Tomales Point in Marin County there is a break until one meets again the groves of the Point Reyes Peninsula.

South of San Francisco Bay the localities are few and widely separated, only five stations being on record:

1. Near Monterey is a locality, discovered by Hartweg in 1845, the trees covering an area of about one or two square miles and situated about two miles from the sea. This locality is about two miles west of old Monterey town, on the westerly slope of the Point Pinos ridge. The stand consists chiefly of young trees three to six feet high, as the tract was burned over a few years ago leaving but few of the older trees. (Fig. 1, page 15.)

2. Near San Luis Obispo is the original station where first collected by Thomas Coulter in 1831.[10]

3. "On the ascent to the Mission of La Purisima," says Hartweg, "the monotony of the bare hills was somewhat relieved by a small forest" of this species.[11]

[10] Don in his original diagnosis writes: "Found by Dr. Coulter at San Luis Obispo in latitude 35°, and at an elevation of 3000 feet above the sea, from which the locality is distant about ten miles." So far as known to us no one has definitely relocated the type station nor indeed any California station south of Monterey.

[11] Hartweg, Jour. Hort. Soc. Lond., vol. 3, p. 227 (1848). He compares the trees with those of the same species he had previously seen and carefully observed on the Monterey Peninsula (l.c., p. 217). In his journal he calls this species *Pinus Edgariana*.

4. Between Enseñada and San Quentin, Lower California, A. W. Anthony in 1889 discovered a form of this species in the San Vicente Valley about six miles from the coast and 250 feet above the sea "where there are a few small trees still left of what was once quite a grove." His specimens represent var. *Anthonyi* Lemmon, Handb. West. Am. Conif., p. 43 (1895). The leaves are strongly round-channeled on the upper side. The stout spur-like umbos curve slightly upward and are more angular than in the North Coast Range form. The apophyses, which curve downwards, are stout-triangular, and drawn down to a bristle-like point. The wings of the seeds are of equal breadth from base to apex.

5. One of the lower summits of Cedros Island "is adorned with open groves of *Pinus muricata,*" according to E. L. Greene, who visited the island in 1885 and records that some of the trees may be seventy feet high. A. W. Anthony collected on the island in 1896 and distributed specimens of its pine tree. The cones are very smooth with low umbos.

The Cedros Island form of the Bishop Pine approaches in cone character the var. *laevigata* of the Monterey Pine. On the mainland the two species are very distinct. While much alike in habit and bark, they differ markedly in cones and foliage. In cultivation at Berkeley, Bishop Pine catkins appear two months after those of the Monterey Pine.

The Bishop Pine is of very great biological interest on account of (*a*) its precocious production of cones, (*b*) the number of cone whorls and branch whorls produced in one season, (*c*) the long-continued attachment of cones on the tree, and (*d*) its intensively gregarious habit.

The trees begin to bear when very young, often at five or six years of age. In the first year of cone production but one or two cones are produced, and these of course stand on the main axis. At twelve to fifteen years the lateral branches begin to bear circles of cones, while the main axis begins to bear more than one circle in a season, very commonly giving rise to two or three and sometimes four or even five circles of cones which at the catkin stage appeared simultaneously. These cone circles are regularly spaced on the shoot at the catkin stage, but are often crowded in age, that is, when the cones are mature; they are fairly complete, that is, with three to five cones in a circle, although in one case of five circles which I noted the second circle was reduced to one cone. While this exhibition of extra circles on the shoot of one season is most pronounced on the terminal axis, it is a peculiarity shared at this stage of development with the lateral branches which often bear two circles of cones, although I have never discovered more than two circles on the wood of one season. On the main axis there are usually extra branch circles corresponding with the cone circles, and in addition branches alternate regularly with the cones in at least the lowest of the cone circles of the season.

The cones persist for long periods, sometimes thirty to forty years. The main axis from near the ground to the summit and all the limbs are, therefore, studded with circles of cones presenting a most striking spectacle. They often become partly buried in the bark or even in the wood, but commonly the cone with its peduncle or peg is broken from the wood at an early stage, sticks in the bark, and is pushed out in advance of the thickening stem. They remain closed five to ten or fifteen years or even longer periods according to situation or conditions, or they may be opened by the heat of ground or forest fires.

The gregarious habit in this species is more marked throughout its range than in any other Californian pine. It is almost always gregarious, and commonly occurs in groves of two to twenty acres with open spaces around or between them, although sometimes the groves are larger and not so well defined.[12] The heaviest and most extensive growth occurs on the low rolling hills of Sonoma County between the mouth of the Gualala River and Stewarts Point, while characteristic and abundant colonies are also a feature of the Point Arena country. There are also fine groves on the swampy flats of Mendocino County between Inglenook and Fort Bragg which are as noteworthy as the Sonoma groves for the density and uniformity of the stand and the height of the trees. In the Sonoma region the Bishop Pine is signally exclusive and does not mix with other species. This feature of exclusiveness is characteristic of the densest stands everywhere, but on the Mendocino bluffs between Fort Bragg and Elk, where the Bishop Pine is thin or occurs as scattered trees, it is associated with Beach Pine and Lowland Fir. On the Point Reyes Peninsula between Tomales Point and Bear Valley it occurs in great abundance on the sterile gravelly clay hills, partly mixed with Tan Oak, Douglas Fir, Live Oak, and California Laurel, partly occurring in dense groves quite without admixture of other species.

Reproduction is vigorous, especially in burned-over districts, the species showing great capacity to retain areas once occupied. Seedlings also come up freely in pasture land and grow vigorously. After four or five years the growth in height is often as much as two feet in a season. Young trees five or ten feet high look not unlike Yellow Pines of the same age. They grow much more thickly than Yellow Pines, however, and form more slender poles. After becoming fifty to seventy feet high the upward growth practically ceases and the top begins to flatten out.

Its relation to wind currents presents some features of interest. Although distinctly a beach pine north of San Francisco Bay and on that account almost everywhere growing in habitats directly facing the ocean, the trees in the dense

[12] See plate 29.

groves protect each other and show comparatively little effect of the ocean winds to which they are directly exposed, except in the case of isolated trees. Such trees are, however, especially common on the Mendocino coast, and individuals unsymmetrically developed or of striking outline give a decided character to the scenery of that long stretch of beach. The Bishop Pine again is the dominant tree in the beautifully wooded district about Inverness, where it forms extensive dense growths on the eastern slopes of the Point Reyes Peninsula, consisting of forests of every age from seedlings to patriarchs, and well protected against heavy gales from the neighboring ocean. While absent from the unprotected or western slopes, scattered trees penetrate the passes leading northwestward to the sea along the sandy lands traversed by the Lighthouse Road and are exposed to the northwest winds from the ocean which sometimes attain a velocity of eighty miles an hour. These outlying sentries bear witness to the stress of the winds. No two are at all alike, and their picturesque outlines furnish abundant studies for those who read into such striking figures the human qualities of determination, tenacity, and defiance. (Plate 13.)

From an economic standpoint the Bishop Pine is thus far judged to be of slight importance. In the region where it is most abundant it forms a beach strip between the Redwood Belt and the ocean, and the lumbering companies have for the most part disregarded it in favor of the abundant Redwood, Douglas Fir, and Lowland Fir. The wood is very resinous, coarse-grained, and light, but makes a hard timber and is sometimes used for piling. The heart-wood is pink or light brown and very durable.

The forestral value of this species is very great on account of its wonderfully economic occupancy with slender poles of the areas which it favors and its rapid growth on indifferent soils. Although at present practically neglected it will in time be looked to as a substitute timber on account of its wood having certain desirable properties. It is cultivated in New Zealand, often on pure sand, where it is regarded as their best shelter plant.

The common name, Bishop Pine, comes from the original locality near San Luis Obispo (Saint Louis the Bishop), although the happiness of the name is further emphasized by the shape of the cone-scales, which are usually developed at tip into conical or mitre-shaped elevations recalling a bishop's cap. It is often called "Swamp Pine" because so frequently an inhabitant of boggy hills or flats, "Prickle-cone Pine" because of its muricate cones, "Pitch Pine" because of its free yield of resin, and "Bull Pine," a slur name of the logging men because they hold it as next to useless for lumber.

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## 16. **Pinus radiata** Don.

### Monterey Pine.

Plate 30.

Pinus radiata Don, Trans. Linn. Soc., vol. 17, p. 442 (1837); Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 214, t. (1849); Lemmon, Erythea, vol. 1, p. 227 (1893); Sargent, Silva N. Am., vol. 11, p. 103, t. 573, 574 (1897); Veitch, Man. Conif., p. 371 (1900); Jepson, Fl. W. Mid. Cal., p. 22 (1901).

Var. binata Lemmon, West Am. Coneb., p. 42 (1895).

*Pinus insignis* Douglas, in Loudon, Arb. Britt., vol. 4, p. 2265, figs. (1838); Hartweg, Jour. Lond. Hort. Soc., vol. 3, p. 226 (1848); Bolander, Proc. Cal. Acad., ser. 1, vol. 3, p. 226 (1866); Kellogg, For. Trees Cal., p. 49 (1888); Lemmon, 2d Rep. Cal. Board. For., p. 112 (1888). Var. *binata* Engelmann, Bot. Cal., vol. 2, p. 128; Watson, Proc. Am. Acad., vol. 11, p. 119 (1876); Franceschi, Zoe, vol. 4, p. 138 (1893); Douglas, Meehan's Mo., vol. 7, p. 44 (1897).

*Pinus tuberculata* Don, Trans. Linn. Soc., vol. 17, p. 442 (1837). Var. *laevigata*, Lemmon, 2d Rep. Cal. Board For., p. 114 (1888).

Beautiful, symmetrical tree or in age with flattened or broken top, 30 to 70 or 115 feet high; foliage a rich dark green; trunk 1 to 4 feet in diameter, vested in a fissured bark which is hard and more nearly black than that of any other Californian pine; needles in 3s, or a few in 2s, 3 to 6 inches long, remaining on the tree 2 to 5 years; staminate catkins yellow, 20 to 40 in a cluster, conic-cylindric, 6 or 7 lines long, the stipes not exserted from the winter bud; ovulate catkins peduncled, 2 to 5 in a circle, 1 to 3 circles formed on the shoot of a season; cones tan or cinnamon color, turned downward, sessile and unequally developed, broadly ovoid and bluntly pointed or globose when open, 2½ to 4½ inches long; scale tips on the outer side toward the base conspicuously developed or swollen into a hemispherical or pyramidal tubercle or boss and all armed with a prickle which usually weathers off; seeds black, minutely roughened on the surface, 3 lines long, bearing a broadly oblong brown wing 2 to 3 times as long; cotyledons 5 to 7.

The Monterey Pine is a strictly littoral species, of very limited range, distributed along the coast south of San Francisco Bay, a distance of one hundred and thirty miles. Its occurrence within this range, however, is by no means continuous, the localities being few and widely separated. It occurs at Pescadero, Monterey, and San Simeon Bay. At Monterey it forms considerable woods on the picturesque stretch of coast hills between Monterey town and Point Lobos, extending inland six or seven miles, and southward as a narrow strip on the mesas of the ocean bluffs as far as Malpaso Creek.[13] This locality is the center of greatest development; the groves are extensive and made up well nigh exclusively of this species. On the average the trees are forty to sixty feet high and one to two feet in trunk diameter, but slender trees in dense stands

[13] For the local distribution see fig. 1, page 15.

are often one hundred feet high.[14] The two largest trees measured by the author stand in a swale below the entrance gate to the Seventeen Mile Drive from the Sur Coast Road: 1. Height 105 feet, diameter 3¾ feet, bark 4½ inches thick. 2. Height 115 feet, diameter 4½ feet. Very near the sea it is often found dwarfed or distorted and it even extends out over the sands of Point Pinos, where it is violently torn by the ocean storms. The third and most southerly locality is that of San Simeon Bay.

On Santa Rosa, Santa Cruz and San Guadaloupe islands occurs the var. BINATA Lemmon. It is either shrub-like or as much as seventy feet high, the needles coarse, mostly in twos, the cones three inches long, the scale tips in the ovulate catkins subulate, deflexed.

The exceedingly restricted foothold of the Monterey Pine on the California coast indicates the species as one surviving from an era when it may have been one of a number of dominating types. Physical factors have undoubtedly combined to narrow its geographic limits. While on the one hand it is a vigorous grower, stands severe ill-treatment in cultivation, thrives in many parts of the world in cultivation, and produces abundant seed, yet it would be impossible for it to extend itself unaided over the dry Coast Range hills or interior valleys. Lack of harmony with the interior climatic conditions is shown by behavior of trees at Chico which, said General Bidwell, rarely survive twenty years. Still it is more than theory which says it had at one time a more extensive distribution than at present. It does not occur today northward of Pescadero, yet good fossil cones are found at Mussel Rock, near San Francisco and in the earthquake of 1906 fossils were uncovered at Preston Point in northern Marin County on the line of the Tomales-Portala fault. These latter were discovered and shown me by C. A. Kofoid. It is noteworthy that both the above are ocean shore stations.

This species reaches its normal height in twenty-five or thirty years and grows with great rapidity, attaining a height of sixty to ninety feet in thirty years, as at Berkeley. It has been extensively planted in California from "early days" for ornamental purposes and for windbreaks, and in later years for establishing a cover on shifting sand-dunes. It has long been cultivated in European botanical gardens and is much planted in the west of England, where it makes a remarkably rapid growth. In Australia it does exceedingly well in cultivation. In New Zealand it is, with the Monterey Cypress, a favorite shelter plant and its wood is now being utilized for butter boxes.

The wood of the Monterey Pine is hard, strong, tough or as often brittle, and durable away from soil. At one time in early days it was sawn into lumber and

[14] Seedling trees in the natural forest on the decomposed granite of the west slope of the Pt. Pinos ridge grow very rapidly. On fire burns swept clean of old trees, young trees were noted in which the annual growth of the leader was commonly four or five feet in length. One tree in its sixth year grew eight feet in height and another one grew thirteen feet. The density of the natural stand is exampled by an area ten feet square on which grew 612 seedlings four years of age (January, 1910).

employed for flooring, for the planking of wharves and in bridge construction. Selected trees were used in boat-building in Spanish-Californian days eighty years since. Perhaps the greatest objection to the wood is its knottiness. On account of the accessibility of superior timbers it is but seldom used for lumber nowadays. It is valued as fuel, although not used so much as formerly. Forty years ago the annual export from Monterey County was 15,000 to 25,000 cords.

The greatest enemy of the Monterey Pine is a borer which infests the trunks. It has made great inroads on planted groves at Palo Alto and is also doing damage to the endemic trees at Monterey. The commercial value of the trees at the latter place is of an esthetic order and while not easily estimated is very great, because they are the main element on the wooded reservation known as the Seventeen Mile Drive, the resort of pleasure seekers and tourists.

The species was first described by David Don in 1837 from specimens collected by Dr. John Coulter at Monterey in 1830. The tree has been best known as *Pinus insignis* Douglas, a name, published, however, at a slightly later period than the name *Pinus radiata*. *Pinus tuberculata* of Don is the form bearing small-sized nearly smooth cones with low umbos. The variety *laevigata* Lemmon is doubtless the same as the latter.

Monterey Pine belongs to the interesting group of closed-cone pines, although the closed-cone character is far less pronounced than in its relatives, the Knob-cone Pine and Bishop Pine. After one to five years the cones open, lose their seeds and remain on the tree a few years or an indefinite period, sometimes fifteen years or more.[15] Seeds are formed on the basal part of the cones (first four or five rows of scales) but do not contain embryos. Nevertheless, fertile seeds are produced in great abundance, come up freely in protected places in the forest, and in culture germinate in open nursery beds in four or five weeks. If kept in the cone they retain their vitality for many years. Seeds ten years old, stored in cones from Monterey, germinated a high per cent in two weeks by forcing. Cones just mature, however, give the greatest number of viable seed.

### 17. **Pinus tuberculata** Gordon.

KNOB-CONE PINE.

Plate 28, figs. 3, 4.

PINUS TUBERCULATA Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 218, t. (1849) not of Don; Pinetum, p. 211 (1858); Bolander, Proc. Cal. Acad., ser. 1, vol. 3, p. 226 (1866); Engelmann, Bot. Cal., vol. 2, p. 128 (1880); Kellogg, For. Trees Cal., p. 51 (1882); Lemmon, 2d Rep. Cal. Board For., p. 116 (1888); Parish, Zoe, vol. 4, p. 351 (1894); Veitch, Man. Conif., p. 386 (1900).

[15] Cones frequently persist eight years. A tree about fifty-five feet high, which stands on the Seventeen-mile Drive a little southerly from Pebble Beach, was estimated to contain not less than 6100 cones in January, 1910. The long straight cone-bearing branches commonly bore as many as twenty-seven circles. There were, furthermore, stray cones well back of these circles which must be twenty-five years old; and also cones on the main trunk which have persisted about thirty years.

*Pinus attenuata* Lemmon, Min. and Sci. Press, vol. 64, p. 45 (1892), Erythea, vol. 1, p. 231 (1893); Jepson, Erythea, vol. 7, p. 107 (1899); Sargent, Silva N. Am., vol. 11, p. 107, tt. 575, 576 (1897); Jepson, Fl. W. Mid. Cal., p. 22 (1901); Merriam, Biol. Sur. Mt. Shasta, p. 33 (1899).

*Pinus californica* Hartweg, Jour. Hort. Soc. Lond., vol. 2, p. 189 (1847) not of Hook. & Arn.

Tree commonly 5 to 30 or sometimes 80 feet high, with slender trunks ⅓ to 1 foot in diameter and rather thin pale yellow-green foliage; needles 3 in a sheath, 3 to 5 inches long; staminate catkins 50 to 60 in spike-like clusters, brownish purple, narrowly conic, 5 to 7 lines long, the anthers furnished with broad rounded crests; ovulate catkins dark-red or straw-brown, 4 to 6 lines long, 3 to 5 or sometimes 7 in a circle, their peduncles ¾ to 1 inch long; cones strongly deflexed, buff in color, narrowly ovate, oblique, acutely or bluntly pointed and somewhat curved, especially at tip, 3 to 6 inches long; scales moderately thickened at tip, except on the outside towards the base where they are raised into conspicuous rounded or pointed knobs; umbos small and contracted into slender prickles which, on old cones, weather away or persist towards the tip; seeds brownish black, ovatish, shortly pointed at base, obliquely truncate at apex, 3 to 4 lines long, the surface minutely roughened, the wing 9 to 12 lines long and 3 to 4 lines broad, broadest nearest the middle; cotyledons 5 to 7.

The Knob-cone Pine inhabits the driest mountain sides and is particularly characteristic of rocky spurs or ridges or sun-scorched slopes, occurring chiefly between 1500 and 3000 feet elevation. It is distributed from southwestern Oregon throughout the Coast Ranges to Southern California, and from Mount Shasta through the Sierra Nevada as far southward as Kinsley in Mariposa County. In the South Coast Ranges it is found on the Moraga Ridge back of Oakland, in the Santa Cruz Mountains, on both slopes of the Santa Lucia Range, thence southward to the San Bernardino Mountains, where it forms, according to Parish, an interrupted belt five miles long and one-half mile wide on the southerly slope. This last is the southernmost locality. In the North Coast Ranges it is known on Mt. Hood in eastern Sonoma County, on Mt. St. Helena, and so on northward to the Devil's Backbone in northeastern Humboldt County, to Trinity County, Siskiyou County and southwestern Oregon, the latter the most northerly locality.

While of extended distribution it is rarely abundant and the localities are for the most part scattered and limited in extent. It is, however, more common northward than southward, and the trees are mostly very small, five to twenty feet high, except at the extreme north, where trees one hundred to one hundred and fifty feet high have been reported.[16]

It is common throughout the Siskiyous, where it occurs between 3000 and 5000 feet, at its upper limits sometimes associated with White Fir stragglers. I have never seen trees in this region over forty-five feet in height. It is a fire-scourged country and this condition favors the tree as against other species.

[16] These figures are given by Lemmon (2d Rep. Cal. Board For., p. 117, 1888).

On the western slope of the Klamath Range on Red Hill is a young forest of Knob-cone Pine covering several square miles, where the trees, four to fourteen feet high, stand in the denser parts of the area as thickly as stalks in a cornfield.

It is frequent in the region of the upper Sacramento and here too is its greatest altitudinal range: it occurs, according to H. M. Hall, near Gregory Station at 1200 feet altitude, and ascends the southerly slopes of Mt. Shasta as high as 5600 feet, according to C. Hart Merriam. The region of greatest abundance lies east of Mt. Shasta, where the only extensive forest of this species is found. On the lava beds of eastern Siskiyou, between Mt. Shasta and southwestern Modoc, is an area of about forty miles long (east and west) and eighteen miles broad where the Knob-cone Pine, according to M. S. Baker, is almost as abundant as the associated Yellow Pine. This lava plateau averages 3500 to 4500 feet above the sea and the tallest trees are sixty-five feet high.

The Knob-cone Pine is apparently absent from the southern Sierra Nevada, a break in the distribution recalling that in the distribution of the Digger Pine. The range of these two species is in some respects similar, but the Knob-cone Pine is enormously less common, with comparatively few localities, grows on the average at higher altitudes and usually in exposed situations, the most hopelessly inhospitable in the California mountains. Typical stations of the Knob-cone Pine are drier and colder in the summer, and colder and with more rain in the winter than Digger Pine stations in the same latitude.

Its inferior stature and unattractive appearance is expressed in the folk-name, Scrub Pine, by which it is best known in the mountains. It is, however, a remarkable pine in three features: constitutional vigor, reproductive capacity, and provision for seed storage. The Knob-cone Pine not only maintains a foothold in the rocky chaparral or on the most sun-baked slopes, but begins to bear crops of cones when only two or three feet high, that is, at six to eight years of age. One, two or even three circles of ovulate catkins are formed on a season's shoot, giving rise at the end of the second year to as many circles of cones, which when there is more than one circle usually overlap each other. The number of cone circles, therefore, does not indicate the age of a particular cone, nor assist in estimating the age of a tree. In the Botanical Museum of the University of California is a strictly terminal globose cluster of seventeen cones. This abnormal specimen was not at all clear to me until I had discovered that more than one circle of ovulate catkins may be formed on the season's shoot. In this case so many congested circles were formed that they arrested completely the further development of the axis.

Tightly closed, the cones remain on the tree almost indefinitely The author's field book shows records of seventeen or eighteen circles of cones on the main axis of trees twenty to twenty-five feet high, fifteen circles on a tree thirteen feet high, and one limb five and a half feet long carried by the author out of

the Santa Lucia Mountains from the rough country east of Cold Spring, beyond Posts, bore forty-five cones.

The increase in diameter of limb usually breaks the stalk of the cone, and the cone with its peg-like stalk is moved outward, but sometimes the stalk does not break and the bark and wood grow out over the base of the cone, gradually burying it. Sometimes, however, the cones open often after four or five years (in days successively of great heat) and fall shortly after, but ordinarily are persistent and tightly sealed, and the seeds are thus effectively stored for long periods and preserve their vitality for many years. At any rate the cones respond to the influence of heat by opening, so that in case of a forest fire destroying the trees the area is promptly resown with the same species.

In cultivation at Berkeley the Knob-cone Pine forms broad-headed trees twenty to twenty-five feet high, which are about as many years old. The cones do not, however, mature good seeds or only one or two per cent. It will doubtless in the future be of great value for reforestation of badly denuded areas or for providing a tree cover for rocky slopes which have never maintained a forest. About eighty-five to one hundred and sixty seeds are formed in a cone.

### 2. Tsuga Carr. Hemlock.

Slender trees with nodding leading shoots. Leaves linear, 2-ranked by the twisting of the petioles or spreading all around the stem; resin canal 1. Petioles jointed, the lower portion persistent as a woody base or projection after fall of the leaf. Staminate catkins pendulous, consisting of a subglobose cluster of stamens on a long stipe arising from an axillary winter bud. Anthers subglobose, tipped with a short spur or knob, their cells opening transversely. Ovulate catkins erect, from terminal winter buds. Cones maturing in the first autumn, pendent; scales thin, longer than the bracts. Seeds with resin vescicles on the surface; cotyledons 3 to 6.—Seven species, two in eastern North America, two in western North America, two in Japan and one in the Himalayas.

Key to the Species.

Leaves in flat sprays; cones ½ to 1 inch long ..... 1. *T. heterophylla.*
Leaves spreading around stem; cones 1½ to 3 inches long ..... 2. *T. Mertensiana.*

### 1. **Tsuga heterophylla** Sarg.

Coast Hemlock.

Plate 31, figs. 1-4; plate 43.

Tsuga heterophylla Sargent, Silva N. Am., vol. 12, p. 73, t. 605 (1898); Jepson, Fl. W. Mid. Cal., p. 19 (1901).

*Abies heterophylla* Rafinesque, Atlant. Jour., vol. 1, p. 119 (1832); Endlicher, Syn. Calif., p. 124 (1847).

*Abies Mertensiana* Gordon, Pinetum, p. 18 (1858); Cooper, Am. Nat., vol. 3, p. 412 (1869).

*Abies Bridgesii*, Kellogg, Proc. Cal. Acad., vol. 2, p. 8 (1863).

*Abies Albertiana* Murray, Proc. R. Hort. Soc., vol. 3, p. 149, figs. (1863).

*Tsuga Mertensiana* Carrière, Traité Conif., ed. 2, p. 250 (1867); Engelmann, Bot. Cal., vol. 2, p. 120 (1880); Kellogg, For. Trees Cal., p. 35 (1882); Lemmon, Bull. Sierra Club, vol. 2, p. 159 (1897).

*Tsuga Albertiana* Kent, in Veitch, Man. Conif., p. 459 (1900).

Western Hemlock, Allen, U. S. Bur. For. Bull., no. 33 (1902).

Graceful conifer, 100 to 200 feet high, with trunk 1 to 4 feet in diameter, the branches and branchlets fine and slender, forming sprays which droop cascade-wise but not pendulous; trunk bark dark red inside, brown on the surface, shallowly fissured longitudinally or nearly smooth, ½ to ¾ inch thick, or sometimes twice as thick and deeply broken into small oblong plates an inch high, producing an irregularly warty appearance; branchlets finely hairy with the leaves mostly spreading in 2 ranks; leaves linear, flat, 3 to 8 lines long, ½ to 1 line wide, blunt at apex, upper side green and with a median furrow, lower side white and with a median ridge, contracted at base into a short but distinct petiole; staminate catkins sub-globose, about 2 lines long, borne on thread-like stalks 2 or 3 lines long, occurring at the ends of branchlets, either solitary or in clusters; cones oblong or conical when closed, roundish when open, ½ to ¾ or 1 inch long, pendulous from the tips of the branchlets, one at a place and borne in great numbers; scales longer than broad, roundish at apex, with entire edge; bracts about one-sixth the length of the scales, broadly triangular with truncate or obtuse summits; seeds light brown, 1¼ lines long with a wing 3 or 4 lines long and in breadth twice the breadth of the seed.

The Coast Hemlock, or, as it is often called, Western Hemlock, inhabits the low coastal region of Washington and Oregon, and of northern California as far south as Elk Creek in southern Mendocino County. It has long been attributed to Marin County, but no exact locality has ever been put on record and the station may be questioned.[17] In Mendocino and Humboldt counties I have never seen it farther than fifteen miles from the coast.

Northward it ranges to Alaska, and is also found abundantly in the Cascade Mountains, especially between 1500 and 3500 feet; in some places it reaches 6000 feet altitude. In California it is associated with the Redwood in the main part of the Redwood Belt, but occurs only as scattered trees. In Oregon it is a more important timber tree and in Washington it forms, according to Allen, 13 per cent. of the forest growth.

The wood is light, tough, straight and even-grained, fairly strong, valuable for construction, and on account of its hardness especially durable for interior finishing. The lumber is readily recognizable by its sour odor. On account of

[17] Recent collectors in attempts to verify this old record have searched thoroughly the Mt. Tamalpais and Bolinas Ridge region without avail.

the strong prejudice of the consumer against the name Hemlock (the Eastern Hemlock yields inferior wood) the timber has no standing in the trade and is sold, when manufactured, either under the invention "Alaska Pine" or falsely as "Oregon Pine" or, again, on account of its freedom from pitch it is substituted for spruce, the millmen being well aware of its merits and excellence. As its good qualities become better known and the prejudice of the consumer lessens or dissolves, it can be sold under its own name, and its market will broaden since it can be used to great advantage in place of higher priced or rarer woods. It has recently been discovered that it is one of few American woods not destroyed by ants in tropical countries. From its fibrous roots have been manufactured threads for cordage, according to Kellogg.

*Tsuga heterophylla* has long been cultivated in the temperate parts of Europe. In England, unlike Douglas Fir, it rarely loses its leader in high wind because of the long whip-like character of that organ. (See plate 43.)

## 2. **Tsuga Mertensiana** Sarg.

### Mountain Hemlock.

Plate 31, figs. 5-7.

Tsuga Mertensiana Sargent, Silva N. Am., vol. 12, p. 77, t. 606 (1898).

*Pinus Mertensiana* Bongard, Veg. Sitcha, p. 163 (1832); Endlicher, Syn. Conif., p. 111 (1847); Ledebour, Fl. Ross., vol. 3, p. 668 (1851).

*Abies Mertensiana* Murray, Rep. Oreg. Exped., no. 1, t. 4, fig. 2 (1853).

*Abies Pattoniana* Murray, Edin. New. Phil. Jour., n. ser., vol. 1, p. 291, t. 9, figs. 1-7 (1855).

*Abies Hookeriana* Murray, Edin. New Phil. Jour., n. sr., vol. 1, p. 289, t. 9, figs. 11-17 (1855).

*Abies Williamsonii* Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 53, t. 7, fig. 19 (1857).

*Abies Pattonii* Jeffrey, Rep. Ore. Exped. (1853); Gordon, Pinetum, p. 10 (1858).

*Tsuga Pattonii* Balfour; Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 539 (1900).

*Tsuga Pattoniana* Seneclauze, Conif., p. 21 (1867); Engelmann, Bot. Cal., vol. 2, p. 121 (1880); Kellogg, For. Trees Cal., p. 31 (1882); Coville, Bot. Death Val. Exped., vol. 4, p. 223 (1893); Lemmon, Bull. Sierra Club, vol. 2, p. 160, t. 23 (1898); Sargent, Gard. & For., vol. 10, p. 1, figs. 1, 2 (1897).

*Tsuga Hookeriana* Carrière, Traité Conif., ed. 2, p. 252 (1867); Lemmon, Erythea, vol. 6, p. 78 (1898).

Patton Hemlock, Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, p. 22 (1902).

Subalpine tree 15 to 50 feet high, with conical trunk ½ to 2½ feet in diameter, bearing branches quite to the ground and forming pyramidal bases which are soon narrowed to slender tops or at somewhat lower altitudes or in denser stands becoming 50 to 90 feet high with trunks 3 to 6 feet in diameter

and clear for 10 to 40 feet; branches slender, on young trees mostly drooping, on old trees horizontal in middle and upper part of crown or a little ascending; the branchlets slender, pubescent and drooping; leaves standing out all around the branch, flattish above, strongly ridged below, bearing stomata on both surfaces, bluntish at apex, ¼ to 1 inch long, less than 1 line wide, shortly petioled; staminate catkins mostly violet-purple, 2 lines long, on stipes 2 to 3 lines long; cones in dense clusters on drooping branchlets in the very top of the tree (less generally scattered over the upper half of the crown), cylindric and tapering to base and apex, 1½ to 3 inches long, ½ to ¾ inch in diameter; opened cones appearing more delicate, oblong in outline or tapering from base to apex, 1 to 1¼ inches in diameter; scales thin, rounded at apex, in the open cone spreading at right angles to the axis or even recurving, their bracts one-third to two-fifths as long, rounded above and tipped with a short point; seeds 2½ lines long, with wings 4 or 5 lines long and broadest above the middle.

The Mountain Hemlock, an inhabitant of granite slopes or marshy meadows in either exposed or sheltered situations at high altitudes, is found in the Sierra Nevada between 7500 and 9500 feet and far northward. The southernmost locality is on the headwaters of Bubbs Creek under the West Vidette in the Kings River region, at about 8000 feet. On Mt. Shasta it is found at an altitude of 7000 to 8000 feet and thence ranges westward to Thompson Peak, Marble Mountain, Siskiyou Mountains, and the Klamath Range on the eastern border of Del Norte.

Beyond our borders it extends to Washington and southeastern Alaska, where it was first discovered near Sitka by R. H. Mertens, naturalist of the Lutki Expedition, in 1827. It was first collected in California by W. Lobb, about 1852, near the source of the north fork of the Feather River and about "Lake Bigler" (Tahoe). W. Murray found it on the Scott Mountains in 1854, where Jeffrey, too, may have collected it in 1851. Jeffrey had discovered it previously on the Mount Baker Range in northern Washington and named it *Abies Pattonii* in honor of George Patton, a member of the Edinburgh Association which sent out Jeffrey; this name, with the vernacular equivalents "Patton's Spruce" and "Patton's Hemlock," was to last a good many years. Newberry discovered it in Oregon after Jeffrey and named it *Abies Williamsonii* in 1857, whence the widely diffused common name, "Williamson's Spruce." Another variant is "Black Hemlock." It is *Tsuga Pattoniana* of Engelmann, but not *Tsuga Mertensiana* of the Botany of California Geological Survey.

The Mountain Hemlock most commonly favors situations where the snow persists in summer patches. In the beginning of the Sierra winter the crowns of young saplings are often bent over and down to the ground with the weight of snow. After winters of very heavy snowfall or where the snow melts tardily, only the curving bow of the stem may be uncovered, the head of the sapling being held fast all summer. Such trees may be permanently dwarfed through

their slight annual growth. The largest trees are found in small groves in semi-protected situations, mostly below 8500 feet in the Sierra Nevada. In the western Siskiyou region it grows in situations similar to those of the high Sierra, that is, in high wet meadows or on divides at the heads of north cañons where the roots are protected by lingering snowbanks until August or September. Sometimes at the most favored altitudes it occurs in the south cañons as well. But wherever it grows its narrow columns of foliage (frequently thirty feet high and about two feet in diameter) with all the lightness and grace of a slender steeple rising from a broad supporting base and ending in a whip-like top, engage the interest and attention of the traveler.

### 3. Picea Link. Spruce.

Trees with tall tapering trunks and thin scaly bark. Leaves narrowly linear, spreading on all sides, jointed near the stem, the lower portion persistent after leaf-fall as a prominent woody base or "peg;" resin canals in ours 2. Catkins from terminal or axillary winter buds. Staminate catkins erect or nodding; anthers with nearly circular toothed crests, opening longitudinally. Ovulate catkins erect. Cones maturing in the first autumn, pendent, usually scattered over the upper half of the tree; scales thin, the bracts shorter than the scales. Seeds without resin vesicles; cotyledons 4 to 15.—About twelve species, seven in North America, the remainder in Europe and Asia. P. Engelmannii Engelm.; branchlets pubescent, cones 2½ to 3 inches long, 1½ inches in diameter when open, scales broad; Rocky Mountains to Arizona and Washington, also near California boundary on Ashland Butte, Oregon.

Key to the Species.

Leaves prickly pointed; cone-scales serrulate; coastal ..... 1. *P. sitchensis.*
Leaves merely acute; cone-scales entire; subalpine ..... 2. *P. Breweriana.*

### 1. **Picea sitchensis** Carr.

Tideland Spruce.

Plate 32, figs. 4-6.

Picea sitchensis Carrière, Traité Conif., p. 260 (1855); Engelmann, Bot. Cal., vol. 2, p. 122 (1880); Lemmon, 3d Rep. Cal. Board For., p. 115, t. 3 (1890), Bull. Sierra Club, vol. 2, p. 157 (1898); Sargent, Silva N. Am., vol. 12, p. 55, t. 602 (1898).

*Pinus sitchensis* Bongard, Veg. Sitcha, p. 164 (1833); Hooker, Fl. Bor. Am., vol. 2, p. 164; Endlicher, Syn. Conif., p. 123 (1847); Ledebour, Fl. Ross., vol. 3, p. 672 (1851).

*Abies Menziesii* Lindley, Penny Cycl., vol. 1, p. 32 (1833); Loudon, Arb. Britt., vol. 4, p. 2321, figs. (1838); Nuttall, Sylva, vol. 2, p. 189, t. 116 (1865); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 56, 90, fig. 21, pl. 9 (1857).

Forest tree 80 to 200 feet high, with trunk 3 to 20 feet in diameter, wide-spreading rigid branches, and drooping branchlets abundantly hung with cones; trunk bark reddish brown, developing roughish deciduous scales, but these not as sharply defined as in spruces generally; branchlets with the leaves spreading equally in every direction but not straight down on the under side of horizontal ones; leaves linear, ½ to 1 inch long, ⅔ to 1 line wide, whitened and flat above but with a median ridge, convex or strongly ridged below, very stiff and usually tapering to a prickly point or the upper leaves less sharp or bluntly pointed; staminate catkins purple, 1 to 2½ inches long and 3 to 6 lines in diameter, borne on a peduncle 2 or 3 lines long, appearing from large conspicuously scaly winter buds; ovulate catkins erect or curving upwards, 1¼ to 1¾ inches long, yellowish green, the bracts longer than the scale; cones dull brown, long-oblong, 2 to 4 inches long and when open 1¼ to 1½ inches in diameter; scales narrow, finely and irregularly toothed, with ovate-lanceolate bracts ½ to ⅔ as long; seeds 1⅓ lines long, the wing 3 to 4 lines long and 1½ to 2 lines broad.

The Tideland Spruce or, as it is best known, Sitka Spruce, is a tree of the coast region and ranges from Mendocino County northward to Alaska. In California it does not occur in abundance and is limited to the immediate vicinity of the ocean shore,—ranging but a few miles from the ocean. On the flats about Crescent City it grows in dense groves or as scattered trees which are at present forty to sixty feet high. It is abundant in the western part of the main Redwood Belt of Del Norte County, where there are trees one hundred and twenty-five to one hundred and seventy-five feet high, and two to eight feet trunk diameter at six feet above the ground; the trunks are remarkably swollen or buttressed, being nearly twice the above diameters at the ground. In Humboldt County it grows on the swampy flats and sand-dunes facing the ocean and is especially prominent in the landscape at the mouth of the Eel River, where there are trees one hundred and ten feet high, many of them showing marked buffeting from the ocean winds which strike them with unmoderated force. A few miles back from the coast a few trees are found in river bottoms. In the Cape Mendocino or Mattole country this species is not represented, but reappears on the dry bluffs of Mendocino County between Fort Bragg and Big River, the southernmost locality. Here the trees are comparatively few in number, only forty to eighty feet in height, and one to two feet in trunk diameter.

On the wet ocean lowlands of Oregon and Washington Tideland Spruce forms an important forest belt composed of trees which often attain a height of two hundred to two hundred and fifty feet and a trunk diameter of ten to twenty feet. It is the largest tree in those States and is extensively lumbered. It is also an important tree in the coast region of British Columbia, where it rivals the Douglas Fir in abundance and utility. On the coast of southeastern Alaska, where it is the dominant forest tree, it covers the islands as well as the seaward mainland and forms an important timber resource.

The wood is light, soft, close-grained, strong, with reddish brown heart-wood, whence "Red Spruce" of the lumbermen. It is used in general construction, ship-building and for interior finish. On account of its great beauty the tree is planted for ornament and may be found in many European arboretums. It is propagated from cuttings as well as from seed. Cones are found all over the tree and seed-production is abundant. My former student, J. P. Tracy, notes that small trees in the sand hills at Samoa bear cones more prolifically than in good soil at Eureka a few miles away, another suggestion that hard conditions tend to precipitate the reproductive activities.

### 2. **Picea Breweriana** Wats.

WEEPING SPRUCE.

Plate 32, figs. 1-3.

PICEA BREWERIANA Watson, Proc. Am. Acad., vol. 20, p. 378 (1885); Sargent, Gard. & For., vol. 2, p. 496 (1889), vol. 3, p. 63, figs. 15, 16 (1890); Lemmon, 3d Rep. Cal. Board For., p. 116, t. 4-6 (1890); Bull. Sierra Club, vol. 2, p. 158 (1897); T. H. Douglas, Gard. & For., vol. 5, p. 591, fig. 102 (1892); Jepson, Erythea, vol. 6, p. 12 (1898); Anderson, Erythea, vol. 7, p. 176 (1899); Sargent, Gard. & For., vol. 5, p. 506 (1892), Silva N. Am., vol. 12, p. 51, t. 601 (1898); Veitch, Man. Conif., p. 430 (1900); Howell, Fl. N. W. Am., p. 789 (1903).

Singular subalpine tree 20 to 95 feet high; branches clothing the trunk to the ground, few and mainly horizontal, especially in the top, ornamented with cord-like branchlets hanging straight down and thus giving a formal effect to the stiffish and very thin crown; trunk ½ to 3½ feet in diameter, its bark thin (½ inch thick), whitish and smoothish on the surface but presenting shallowly concave scars from which have fallen thick scales of irregular shape, mostly 1 to 4 inches long and half as wide; inner bark white, outer bark red-brown; leaves borne all round the stem, ½ to 1 inch long, roundish and green below, whitish above on either side the conspicuous median ridge, obtuse at apex; staminate catkins yellow-brown, 1 inch long; ovulate catkins dark purple, 1¼ inches long, with the sides of the scales towards their apex turned up in such a way that the surface of the catkin presents rhomboidal areas, the bracts appressed, with finely toothed edges; cones narrowly cylindrical, 3½ to 4¼ inches long, 1¼ to 1½ inches in diameter when open; scales broadly ovate, thickish, rounded at apex, with smooth entire edges; bracts oblong, acute, one-fifth to ⅓ as long as the scales; seeds 1½ to 2 lines long with wings 4 to 4½ lines long.

The Weeping Spruce is an exceedingly local species inhabiting a few isolated peaks and summits of northwestern California and adjacent Oregon, where it is distributed from northern Trinity through the Siskiyous northward to the high mountains south of Rogue River and westward to the Oregon Coast Range. It favors cup-like hollows at the head of north cañons where the snow lies ten to twenty feet deep half the year and where lingering drifts persist until July or September. Occasional trees occur on rocky shoulders or in the heads of

south cañons, quite barren of wasting snow in July, but where in all probability snow banks up heavily for seven or more months of the year. It is associated with Red Fir (*Abies magnifica*), Silver Pine (*Pinus monticola*), Mountain Hemlock (*Tsuga Mertensiana*) and Douglas Fir (*Pseudotsuga taxifolia*), but is far more exacting in its demands than those species. The cool, moist high areas which meet its requirements, that is, altitudes of 6000 to 7000 feet carrying snow nearly all the year, are not numerous in its region.

It has been seen by the author at the following localities: 1. Packers Mountain, three miles west of Marble Mountain, on the headwaters of a creek flowing into the Klamath River. 2. Ridge two miles west of Cudahay Valley on the Marble Mountain trail to Dutch Henry's. 3. In a north cañon, two miles west of Elbow Camp, on the Kelsey Trail across the Klamath Range from Cottage Grove to Crescent City. 4. Willis Hole, on same trail, a considerable forest. 5. Two miles west of Cedar Camp (which is below trail two miles west of Willis Hole), scattered trees. 6. Between "Onion Patch" and the divide of the Klamath Range along the ridge followed by the Kelsey Trail (some ten miles south of Preston Peak, the great landmark of the region), trees occurring at intervals in heads of both north and south cañons. This is a country long scourged by fire, where this species seems least at home under present conditions of the slope and cover. 7. Head of Indian Creek, Happy Camp Trail across the Siskiyous.

The Weeping Spruce was first collected on the headwaters of the east fork of the Illinois River, northern slopes of Siskiyou Mountains, northern California, just south of Waldo, Oregon, by Thos. Howell, the pioneer botanist of Oregon. It probably occurs throughout the high Siskiyous as it has been reported from the head of Sucker Creek (Orrin Russel) and Red Mountain (W. G. Kropke). It has also been reported from the Oregon Coast Range on the divide between Cañon Creek and Fiddler's Gulch (T. H. Douglas); eastern end of the Chetco Range, Oregon and high mountain tops south of Rogue River, Oregon (A. J. Johnson); South Russian Creek on North Fork Salmon River (James Davis); Thompson's Peak, Trinity Mountains (Alice Eastwood); and Cinnabar Trail, fifteen or twenty miles above Castella (acc. F. B. Kellogg).

The most remarkable feature of the Weeping Spruce resides in its pendulous branchlets which at a glance distinguishes this tree from all other trees in the forest and imparts to it an air of great singularity. In the top of the tree they are one to two feet long, gray-barked, glabrous, about one-eighth inch thick; in the lower part they may be twice as long, with the thickest portion of no greater diameter than a lead-pencil.

The species is named in honor of William H. Brewer, a one-time devoted student of the California trees, botanist of the State Geological Survey from 1860 to 1864, after whom was named Mt. Brewer in the Sierras. He is now Emeritus Professor in Yale University.

## 4. Pseudotsuga Carr. False Fir.

Large trees with flat, short-petioled leaves, spreading around the stem or on horizontal branches often somewhat 2-ranked. Staminate catkins axillary, the anthers tipped with a spur and opening obliquely. Ovulate catkins erect, terminal or axillary. Cones pendent, maturing in the first autumn; scales thin, rounded, shorter than the slender acutely 2-lobed bracts which bear a spear-like point in the notch. Seeds without resin vescicles; cotyledons 5 to 12.—Pseudotsuga consists of three species, two in America and one in Japan. In botanical relationship it stands in an intermediate position among the spruces, hemlocks and firs. The general habit and branching, the leaves spreading all around the stem, the medium-sized pendent cones borne all over the tree, the persistent cone-scales, the seed without resin vescicles—in all these features it resembles the spruces, differing from them most markedly in its bark, which is not thin and scaly, and in its exserted bracts. In its petioled blunt leaves, often pendent leader of very young trees, and persistent cone-scales it is like the hemlocks. In its roughly fissured thick bark and exserted bracts it resembles the firs. Its peculiar cone bracts, signally different from those of any other conifer, and the obliquely dehiscing anthers are the chief marks of the distinctive genus Pseudotsuga.

Key to the Species.

Cones 1¾ to 3½ inches long; bracts conspicuously exserted; Sierra Nevada and Coast Ranges ..... 1. *P. taxifolia*

Cones 4 to 7½ inches long; bracts protruding little; S. California only ..... 2. *P. macrocarpa*

### 1. **Pseudotsuga taxifolia** Britton.

Douglas Fir.

Plate 33, figs. 1-3.

Pseudotsuga taxifolia Britton, Trans. N. Y. Acad. Sci., vol. 8, p. 74 (1889); Lemmon, 3d Rep. Cal. Board For., p. 130, tt. 10, 11 (1890), Bull. Sierra Club, vol. 2, p. 161, pl. 22 (1898); Sudworth, 21st Rep. U. S. Geol. Sur., pp. 516, 525 (1900); Jepson, Fl. W. Mid. Cal., p. 19 (1901).

*Pinus taxifolia* Lambert, Pinus, vol. 1, p. 51, t. 33 (1803); Pursh, Fl. Am. Sept., vol. 2, p. 640 (1814).

*Abies taxifolia* Rafinesque, New Fl. Am., vol. 1, p. 38 (1836); Torrey & Gray, Pac. R. Rep., vol. 2, p. 130 (1855).

*Abies mucronata* Rafinesque, Atlant. Jour., p. 120 (1832); Endlicher, Syn. Conif., p. 126 (1847).

*Pseudotsuga mucronata* Sudworth, Contrib. U. S. Nat'l Herb., vol. 3, p. 266 (1895); Sargent, Silva, N. Am., vol. 12, p. 87, t. 607 (1898); Lemmon, Erythea, vol. 5, p. 22 (1897); Lloyd, Bull. Torr. Club, vol. 25, p. 90, pl. 327 (1898).

*Abies Douglasii* Lindley, Penny Cycl., vol. 1, p. 32 (1833); Loudon, Arb. Britt., vol. 4, p. 2319, fig. (1838); Bentham, Pl. Hartweg, p. 57 (1840); Nuttall, Sylva, vol. 2, p. 187, t. 115 (1865); Torrey, Pac. R. Rep., vol. 4, p. 141 (1857); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 54, 90, pl. 8, fig. 20 (1857); Cooper, Pac. Rep., vol. 12, pt. 2, pp. 24, 69 (1860).

*Pinus Douglasii* Don, in Lambert, Pinus, vol. 3, t. 90 (1837); Hooker, Fl. Bor. Am., vol. 2, p. 162, t. 183 (1854); Endlicher, Syn. Con., p. 87 (1847); Bigelow, Pac. R. Rep., vol. 4, pt. 5, p. 17 (1856).

*Pseudotsuga Douglasii* Carrière, Traité Conif., ed. 2, p. 256 (1867); Engelmann, Bot. Wheeler, p. 257 (1878), Bot. Cal., vol. 2, p. 120 (1880); Kellogg, For. Trees Cal., p. 32 (1882).

Red Fir, Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, pp. 24, 30, 31, 49 (1902).

Forest tree 70 to 250 or possibly 300 feet in height, in dense stands often exhibiting clear trunks 100 to 200 feet high and 4 to 8 feet in diameter; bark on young trees smooth, gray or mottled, sometimes alder-like; on old trunks 1 to 6½ inches thick, soft or putty-like, dark brown, fissured into broad heavy furrows, in cross section showing alternating layers of red and white; branchlets usually drooping, the leaves spreading all around the stem or on horizontal branchlets spreading more or less to right and left but not in truly flat sprays; leaves ½ to 1½ inches long, ½ to 1 line wide, linear, rounded or blunt at apex, flat with a median groove above and a ridge below, green, with two pale longitudinal bands on the under surface, very short-petioled; staminate catkins conic-cylindric, 4 or 5 lines long, exserted from winter buds on a peduncle 2 or 3 lines long and scattered along the under side of the branchlets; ovulate catkins erect, terminal or lateral, 1 inch long, the bracts very conspicuous on account of the small size of the scales at this stage; cones pendulous, long-oval and more or less pointed, 1¾ to 2½ or 3½ inches long, when open 1¼ to 1¾ inches in diameter; scales broad and rounded at apex; bracts conspicuously exserted, broadly linear and bearing in the deep notch at apex a spear-like point; seeds 3 lines long, the wings 1¼ to 1⅔ times as long.

The Douglas Fir, by botanists called Douglas Spruce, grows in the Coast Ranges and Sierra Nevada of middle and northern California, where there is a seasonal rainfall of 30 to 35 inches or higher, and is widely distributed northward to British Columbia, thence southward through the Rocky Mountain region to northern Mexico. In the Sierra Nevada it is found in the main timber belt as an associate of the Yellow Pine and White Fir, from the headwaters of the San Joaquin River on Stevenson Creek northward to Mt. Shasta, chiefly between 3000 and 5500 feet altitude; in a few very limited areas it is fairly common, but generally it forms but a small part (1 to 5 per cent.) of the Sierra forest.

In the North Coast Ranges the Douglas Fir in company with Tan Oak, Oregon Oak and Yellow Pine forms about 25 per cent. of the wooded areas in the district between the inner Coast Range and the summits of the seaward or outer Coast Range which bear on their western slopes and river basins the

"Redwood Belt." In the Redwood Belt itself it forms only about 5 per cent. of the total stand. Altitudinally it ranges from the ocean bluffs of the north coast and the very shores of the ocean on the Point Reyes Peninsula, where its roots are lapped by high tides, to 2000 to 4000 feet in the Napa, Yollo Bolly and Trinity mountains. South of San Francisco Bay it is less common, being restricted to the Santa Cruz Mountains and the Santa Lucia Mountains, the latter region being its southernmost locality in California.

The tree reaches its greatest development in the coast region of Washington, Oregon and British Columbia, where, under the stimulus of rich soils, an annual mean temperature of 50°, and a seasonal rainfall of 60 to 130 inches, it forms vast forests with an average height of 175 to 250 feet with very slight admixture of other species, and cuts 50 to 100 thousand feet board measure to the acre.

From Alberta it ranges southward all through the Rocky Mountain region to northern Mexico and Arizona. Thus the Douglas Fir has a greater range and grows under more diverse conditions of exposure to cold and heat, of humidity, aridity and soil than any other North American tree except the Yellow Pine (*Pinus ponderosa*).

No other American tree is so important in the lumber industry, considering the quality of timber which it produces, its remarkable abundance and the size and length of the logs, the great amount of heartwood and freedom from knots, shakes or defects. The wood is light, straight and fairly close-grained, strong, moderately tough and hard to work. The sapwood is nearly white, the heartwood reddish-brown ("Red Fir") or yellow ("Yellow Fir"). The young rapid growth in the open woods produces "Red Fir," the older slower growth in denser woods is "Yellow Fir." Every tree to a greater or less extent exhibits successively these two phases, which are dependent upon situation and exposure. When, however, the log has passed through the sawmill and comes out as lumber, the manufactured product is universally known in the trade as "Oregon Pine." It is the standard timber for dock-piles, spars, masts for ships and general ship construction, while it is also largely consumed for flooring, sills, joists, studding and rafters in buildings. It is furthermore held in the highest esteem by engineers in bridge building and similar construction because it offers the greatest possible combination of lightness, stiffness and strength and furnishes pieces of unequaled length. Sticks two feet square and up to one hundred feet are regularly offered in the trade lists, while twice that length can be supplied. For interior finishing it offers beautiful patterns, but is liable to sweating under heat.

On account of its cheapness and high quality, it has always been freely imported into California from Oregon and Washington, and by reason of low

freight rates by water it has successfully competed with local product manufactured within a short distance of the Californian forests. Before the days of barb-wire great quantities were used as planks in fencing. It is also consumed by the mines in the Sierra Nevada for timbering. The Gwin Mine alone sends down its shaft 250,000 feet per month. As a substitute timber it is used for the poles and running gear of wagons. The wood makes excellent firewood, even when green; slabs from the Northwestern Mill at Willits are sold at $1.50 per cord on board car at Ukiah. The long lower limbs of broad-crowned trees grown in the open are very pitchy and make durable fence posts, although ordinarily Douglas Fir wood soon rots in contact with soil. Douglas Fir has no tap-root or an indifferently developed one. It is, compared to Redwood, very easy to clear from land, or the stump, if left alone, will rot off in a few years.

Its habits of growth, vigor, vitality, and aggressiveness, as well as the high commercial quality of the log produced, marks the tree as a superior forestral species. It reproduces itself abundantly, promptly occupies logged or burned areas and usually shows a strong capability for extending its territory. These characteristics are due to its light seeds with persistent wings which secure wide dispersal, their viability, the rapid growth of the seedlings and their exceptional vigor. Young saplings in California show on the average a growth in height of six inches to two feet per year. Their leaders are often pendent.

The forests of Douglas Fir are very dense and very sombre. It is only in spring that the fresh growth, like dainty light-green plumes, relieves the dull monotone of the woods. Although of slight esthetic charm it is botanically an interesting tree. The many popular names by which it is known indicate its puzzling botanical character. Its trunk bark resembles that of a fir, either in the pole or adult stage. While this is the only fir-like characteristic in a field view of *Pseudotsuga taxifolia,* nevertheless woodsmen recognize a tree by the trunk and therefore call this species "Red Fir," "Yellow Fir," or simply "Fir," the last designation especially in those localities where there is no true fir. The name "fir" as applied to the species is so well established among woodsmen that for the sake of intelligibility the combination Douglas Fir, which prevents confusion with the true firs and has been adopted by the Pacific Coast Lumberman's Association, is here accepted, notwithstanding that the name used by botanists, "Douglas Spruce," is actually more fitting on account of the greater number of spruce-like characteristics. While related to all of the genera Picea, Tsuga, and Abies, it is neither true spruce, hemlock, nor fir, but the marked type of a distinct genus, namely Pseudotsuga.

## 2. **Pseudotsuga macrocarpa** Mayr.

### Desert Fir.

Pseudotsuga macrocarpa Mayr, Wald. Nordam., p. 278 (1890); Lemmon, 3d Rep. Cal. Board For., p. 134 (1890), Bull. Sierra Club, vol. 2, p. 162 (1897); Coville, Bot. Death Val. Exped., p. 223 (1893); Parish, Zoe, vol. 4, p. 352 (1894); Leiberg, 20th Rep. U. S. Geol. Sur., pt. 5 (For. Res.), p. 442 (1900).

*Tsuga macrocarpa* Lemmon, Pac. Rural Press, vol. 17, p. 75 (1879).

*Abies Douglasii* var. *macrocarpa* Torrey, in Ives, Rep. Colo. River, pt. 4, p. 28 (1861).

*Pseudotsuga Douglasii* var. *macrocarpa* Engelmann, Bot. Cal., vol. 2, p. 120 (1880).

Tree 30 to 60 or occasionally 90 feet tall, with very long lower branches; bark, foliage, catkins, and cones very similar to those of the Douglas Fir; bark dark or black; leaves slightly curved; cones 4 to 7½ inches long, 3 inches in diameter; bracts protruding little or not at all beyond the scales, except the lowest, the tails of which are often as much as ¾ inch long.

The Desert Fir, also called Big-cone Spruce, inhabits mostly sheltered situations of the mountains of Southern California at an altitude of 1700 to 4000 feet. The localities are not numerous and are not areas of great extent. It is found in the San Felipe Cañon, between Banner and Julian, where it was first discovered by Lieutenant Ives in 1858; also on the northerly slope of Palomar, and in well watered cañons on the westerly side of Mt. San Jacinto at 3000 to 4000 feet elevation. It is most common on western or southern exposures of the southerly side of the San Bernardino and the Sierra Madre ranges, chiefly between 2500 and 8000 feet, and is rare on their northerly slopes, occurring at higher altitudes. It also occurs on the south slope of the Sierra Liebre. The most northerly locality is in the San Emigdio Mountains of the Tehachapi Range and the most westerly in the Santa Inez Mountains of Santa Barbara County.

It has long been regarded as an arid region variety of the Douglas Fir and is at most a subspecies. The wood is much inferior to that of its northern relative, the economic value of the tree lying in quite another direction. Inured to semi-desert conditions and at the same time vigorous in growth, it promises to be of importance in the extension of forest areas in the southern part of the State, where a forest cover, as such, is of many times more value to the valley communities than the trees converted into lumber could possibly be.

## 5. Abies Link. Fir.

Highly symmetrical trees of lofty stature, the branches in regular whorls and ramifying laterally, forming flat sprays. Leaves linear, about a line wide, flat or 4-angled, whitened beneath, spreading in 2 opposite directions or even 2-ranked, or more often curving upwards, leaving a smooth circular scar when they fall; resin canals in ours 2. Catkins from axillary winter buds. Staminate catkins borne on the under side of the branches, mostly in the upper half of the tree; anthers tipped with a knob, their cells opening transversely. Ovulate catkins erect, on the upper side of the topmost spreading branches. Cones erect, maturing in the first autumn, falling to pieces on the tree; scales thin, incurved at the broadened apex; bracts often exserted. Seeds with resin vescicles; cotyledons 4 to 10.—Northern hemisphere, especially in the high mountains or far north, some twenty-three species. Seven species are found on the Pacific Coast, two of them beyond our borders, *viz.*: A. amabilis Forbes, cones 3½ to 6 inches long, the slender-tipped bracts ½ as long as scales; Cascade Mountains. A. lasiocarpa Nuttall, cones 2½ to 4 inches long, the rounded or emarginate bracts with long slender but not exserted tips; Rocky and Cascade mountains to Alaska; related to *A. concolor*.

### Key to the Species.

Leaves of lower and uppermost branches slightly different.

Cones 2 to 5½ inches long; bracts not exserted.

Leaves glaucous or dull green, flat or on cone-bearing branches keeled above, acute or rarely notched at apex, spreading in 2 ranks or curving upwards, with a twist in the short petiole; old bark roughly and deeply furrowed, drab or grayish; high Sierra and Coast mountains ..... 1. *A. concolor.*

Leaves dark lustrous green, white beneath, notched at apex, usually spreading in 2 ranks, on cone-bearing branches often blunt, curving upwards; bark white, smooth or fissured into low flat ridges; north coast only ..... 2. *A. grandis.*

Cones 4 to 8 inches long, the bracts concealed or exserted; leaves ridged above and below so as to be 4-sided, somewhat compressed, thicker on the uppermost branches, curving upwards but not twisted, sessile; old bark deeply divided into roughly broken ridges, reddish brown; high Sierra and Coast mountains ..... 3. *A. magnifica.*

Cones 4 to 5 inches long, the exserted bracts reflexed, usually concealing the scales; leaves of lower branches flattened, distinctly grooved above; Trinity Summit to Washington ..... 4. *A. nobilis.*

Leaves alike all over tree; cones with conspicuous bracts, the exserted portion long and bristle-like; bark light brown, smoothish; Santa Lucia Mountains only ..... 5. *A. venusta.*

## 1. **Abies concolor** Lindl. and Gord.

### White Fir.

Plate 34, figs. 1-3.

Abies concolor Lindley & Gordon, Jour. Hort. Soc. Lond., vol. 5, p. 210 (1850); Engelmann, Bot. Cal., vol. 2, p. 118 (1880); Kellogg, For. Trees Cal., p. 27 (1882); Coville, Bot. Death Val. Exped., p. 224 (1893); Sargent, Silva N. Am., vol. 12, p. 121, t. 613 (1898); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 523, pl. 93 B (1900).

*Abies Lowiana* Murray, Proc. R. Hort. Soc., vol. 3, p. 317, figs. (1863); Lemmon, 3rd Rep. Cal. Board For., p. 148, t. 15, 16 (1890), Sierra Club Bull., vol. 2, p. 164 (1898).

*Abies grandis* var. *Lowiana* Masters, Jour. Linn. Soc., vol. 22, p. 175, figs. 6, 7 (1886).

*Abies concolor* var. *Lowiana* Lemmon, West. Am. Coneb., p. 64 (1895); Veitch, Man. Conif., p. 502 (1900).

White Fir, Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nev., pp. 23, 50 (1902).

Forest tree 60 to 150 or 200 feet high, with a narrow crown composed of flat sprays and a trunk naked for ⅓ to ½ its height and 1 to 6 feet in diameter; bark smooth, silvery or whitish in young trees, becoming thick and heavily fissured into rounded ridges on old trunks and gray or drab-brown in color, in section showing dull brown areas separated by a coarse light-colored mesh; leaves ½ to 2½ (commonly 1 to 1½) inches long, flat, often with a median channel on upper side, or on the uppermost branches keeled, a prominent midrib beneath with a broad depressed stomatal band on either side, contracted at base into a very short petiole, acutish, obtuse or slightly notched at summit, spreading in 2 ranks or more or less erect by a twist in the very short petiole; staminate catkins cylindric, straw-yellow or red, ½ inch long or less; cones brown, oblong, rounded at summit and base, 2 to 5½ inches long, 1 to 1¾ inches in diameter; scales broad and rounded; bracts about ½ as long as the scales, roundish and finely toothed, often with a notch at top and usually terminating in a short slender point; seed 5 lines long, its wing 6 or 7 lines long, 5 or 6 lines wide, widening towards the truncate apex.

The White Fir, also locally but wrongly known as "Silver Fir" and "Balsam Fir," forms an important part of the main timber belt in the western slopes of the Sierra Nevada. Although growing as high as 8000 feet it occurs mainly between 4000 and 7000 feet as an associate of the Sugar Pine, Yellow Pine, and Incense Cedar. Usually ranging to higher altitudes than any of the species named, it does not range into the lower part of the Yellow Pine Belt and demands far better protection and soil conditions than Yellow Pine. In the Coast Ranges it grows on the highest summits but only where these reach altitudes in excess of 5000 feet, being found from the Siskiyou Mountains to the Salmon Mountains and Trinity Summit and thence southeastward to the

Yollo Bollys or inner Coast Range. On the Yollo Bollys it occurs as far south as Snow Mountain in Lake County. Thence southward no White Fir has been reported until one reach Mt. Pinos in Ventura County, a gap of three hundred and sixty miles.

On the high mountains of Southern California it is a common tree and crowns the protected portion of the summits of the Sierra Madre, San Bernardino, and San Jacinto ranges, Palomar and Cuyamaca, the most southerly locality being on Mt. San Pedro Martir in Lower California. Its altitudinal range in Southern California is from 4000 to 11,000 feet. From California it ranges eastward to the Rocky Mountains and northward to southern Oregon. The Rocky Mountain form is the type of species, while the Californian is called variety *Lowiana* Lemmon by some botanists.

The wood is whitish, light, coarse-grained, not strong but very easily worked. It is sawn into boards and square timber for general construction and furnishes a large amount of clear lumber which is, however, of an inferior grade as compared with Douglas Fir or Yellow Pine. It is especially prized for packing boxes or butter cases where a scentless wood is a desideratum. Great quantities are consumed in the manufacture of fruit-boxes for which there is an extensive local demand. In the woods the logs are used for chutes and the cribbing of logging-railway trestles to effect transportation of the more valuable Sugar and Yellow Pine.

Reproduction under natural conditions is abundant, but ground fires and sheep, those two pitiless scourges of the high Sierra, destroy millions of seedlings every year. The withdrawal of forest lands in the Sierra Nevada and their nationalization in national forests, now in part accomplished, is the practicable and speedy way in which such evils in this district may be obviated.

## 2. **Abies grandis** Lindley.

### Lowland Fir.

Abies grandis Lindley, Penny Cycl., vol. 1, p. 30 (1833); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 25, 69 (1860); Nuttall, Sylva, vol. 2, p. 192 (1865); Engelmann, Bot. Cal., vol. 2, p. 118 (1880); Kellogg, For. Trees Cal., p. 24 (1882); Masters, Journ. Linn. Soc., vol. 22, p. 174, pl. 3, figs. 4, 5 (1886); Lemmon, 3rd Rep. Cal. Board For., p. 146 (1890), Sierra Club Bull., vol. 2, p. 164 (1898); Veitch, Man. Conif., p. 510 (1900); Howell, Fl. N. W. Am., vol. 1, p. 787 (1903); Sheldon, For. Wealth Oreg., p. 16 (1904).

*Pinus grandis* Douglas, Comp. Bot. Mag., vol. 2, p. 147 (1836); Hooker, Fl. Bor. Am., vol. 2, p. 163 (1854); Endlicher, Syn. Conif., p. 105 (1847).

*Picea grandis* Gordon, Pinetum, p. 155 (1858); Loudon, Arb. Britt., vol. 4, p. 2341, figs. (1838).

Forest tree 40 to 160 feet high with horizontal branches, the trunk 1 to 3 feet in diameter and vested in a smooth white or light brown bark which is smooth or shallowly broken into low flat ridges; in section the inner bark light brown, the outer bark dark red with a mesh of purple lines running through it; horizontal branches with the leaves spreading by a twist at base in two ranks and so making a flat spray, or in any event tending to right and left, those originating on top of the stem having the peculiarity of being much shorter than those coming from the sides; leaves flat, 1 to 2 inches long, notched at apex, the upper side dark lustrous green and with a median channel, the lower side with two white bands separated by a ridge; staminate catkins straw-color, cylindric, 5 or 6 lines long, borne on a peduncle 3 or 4 lines long, the crest of the anthers mostly 2-toothed; ovulate catkins borne in upper half of the tree; cones long-oblong in outline, 2½ to 4 inches long, 1½ to 1¾ inches in diameter; scales with a broad rounded summit, and narrow stalk-like base broader than long; bracts very small, with a short awl-like point set on the roundish apex and half as long as the scales; seeds drab-color, 4½ lines long with a wing somewhat longer and twice as broad.

The Lowland Fir, called by the woodsmen of the north coast Stinking Fir on account of the disagreeable odor of the wood, is confined in California to the coast region of northern Sonoma, Mendocino, Humboldt, and Del Norte counties where it is commonly an associate of the Redwood, but ordinarily does not range inland more than ten miles. Altitudinally it is found from near sea-level to about 1500 feet in the mountains. Northward it ranges to Vancouver Island and to Montana.

The wood, which is white and soft, is not held in esteem by California lumbermen and is only sawn as a substitute timber or for temporary purposes, such as bunk-houses for logging crews in the woods, or for fences or sheds about the mills. It perishes very quickly when exposed to the soil but may be profitably used for inside work. It is valued for shelving in merchandise stores as the odor drives away predatory insects. In Oregon it is a far more valued timber for lumber and is also manufactured into barrel-staves, shakes, and packing cases. In Washington and Oregon it grows to greater size than in California, exceptional trees being two hundred and fifty to three hundred feet in height and four feet in trunk diameter.[18]

*Abies grandis* was discovered near the mouth of the Columbia River in 1831 by David Douglas, who introduced it into European arboretums. It is common in cultivation. In the literature it is called Grand Fir, White Fir, and Oregon White Fir.

[18] Sargent, Silva N. Am., vol. 12, p. 117.

### 3. **Abies magnifica** Murray.

RED FIR.

Plate 35.

ABIES MAGNIFICA Murray, Proc. R. Hort. Soc., vol. 3, p. 318, figs. 25-33 (1863); Engelmann, Bot. Cal., vol. 2, p. 119 (1880); Veitch, Man. Conif., p. 516 (1900); Lemmon, 3rd Rep. Cal. Board For., p. 142, t. 13 (1890), Sierra Club Bull., vol. 2, p. 165 (1898); Coville, Bot. Death Val. Exped., p. 224 (1893); Sargent, Silva N. Am., vol. 12, p. 137, t. 618 (1898); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 537, pl. 95 B (1900).

Var. SHASTENSIS Lemmon, 3rd Rep. Cal. Board For., p. 145 (1890).

Var. XANTHOCARPA Lemmon, 3rd Rep. Cal. Board For., p. 145, t. 14 (1890).

SHASTA FIR, Leiberg, U. S. Geol. Sur.—For. Cond. Northern Sierra Nevada, pp. 33-46 (1902).

*Abies nobilis* var. *magnifica* Kellogg, For. Trees Cal., p. 29 (1882); Masters, Jour. Linn. Soc., vol. 22, pp. 187, 189, figs. 20, 21 (1886).

Forest tree 60 to 125 or even 175 feet high, with trunk 1 to 5 feet in diameter and a narrowly cone-shaped crown composed of numerous horizontal strata of fan-shaped sprays; bark on young trees whitish or silvery, on old trunks dark red, very deeply and roughly fissured, in section showing reddish brown areas set off by a sharply defined purple mesh; leaves 1 to 1½ inches long, ridged above and below so as to be equally 4-sided, although more or less compressed, slightly contracted just above base, acutish at apex, those on the under side of the branches spreading right and left, in the top of the tree more thickened, erect, incurved and hiding the upper side of the branch; staminate catkins dark red, about 3 lines long; cones, when young, beautiful dull purple objects, when mature becoming brown, 4 to 8 inches long, 2½ to 3½ inches in diameter, broadly oval in outline, the broad scales with upturned edges; bracts very variable in form and length, sometimes concealed beneath the scales, sometimes conspicuously exserted and reflexed, their terminal portion commonly transversely oblong, or broad with a short spreading awl-like point or pointless; seeds 7 lines long with a semi-flabelliform wing 8 lines long and 11 lines broad.

The Red Fir, also known as Red-bark Fir, Shasta Fir, and Golden Fir, is common at an altitude of 7000 to 9000 feet in the Sierra Nevada and on Mt. Shasta, where there are extensive forests. It is also found on the summits and ridges of the Trinity and Salmon mountains and on the inner North Coast Range (Yollo Bollys) as far south as Snow Mountain, but has not as yet been reported from any locality in the South Coast Ranges or Southern California. The most southerly locality in the Sierra Nevada is on the divide between White and Kern rivers. The following forms have been described:

Var. **shastensis** Lemmon. Bracts rounded or obtusely pointed at apex, usually conspicuously exserted.—Mt. Shasta and elsewhere in northern California.

Var. **xanthocarpa** Lemmon. Cones 4 or 5 inches long, yellowish until maturity.—Meadow Lake and elsewhere at high altitudes. Not seen by us.

Red Fir reproduces rapidly under normal conditions but not where sheep run continuously. Leiberg noted many plots "varying from one acre to three or four acres, scattered along the ridges from Weber Creek to the Rubicon River, on which the grass and weeds had been so thoroughly eaten out that even the sheep abandoned them. On such tracts, left undisturbed for four or five years, Shasta [Red] Firs covered the ground to the number of 10,000 to 15,000 trees to the acre."

The wood is reddish, soft, close-grained, heavier than White Fir, fairly strong and remarkably durable in contact with soil. It is sawn into lumber for ordinary construction, and on account of its durability is employed for bridge-timbers and for cage-guides lining the shafts of mines.

Red Fir is remarkable for its great size, the symmetrical beauty of its stratified crown and the thickness of its heavily furrowed drab or reddish bark. Of very great interest in the upper portion of the Sierra timber belt, where it is associated with the Silver Pine, Jeffrey Pine and Tamrac Pine, it is eagerly watched for by travelers on mountaineering climbs as a tree of distinctive charm and a sign of higher altitudes.

### 4. **Abies nobilis** Lindley.

NOBLE FIR.

ABIES NOBILIS Lindley, Penny Cycl., vol. 1, p. 30 (1833); Engelmann, in Bot. Cal., vol. 2, p. 119 (1880); Sargent, Silva N. Am., vol. 12, p. 133, t. 617 (1898).

Forest tree 80 to 250 feet high, with slender branchlets and roughly broken trunk bark; leaves on the lower branches flat, sharply and deeply grooved above, on upper branches rounded above and obscurely ridged below, erect, ¾ to 1½ inches long; cones oblong-cylindrical, 4 to 5 inches long, 2 to 2½ inches in diameter; scales surpassed and often wholly concealed by the reflexed spatulate bracts which are rounded and fimbriate and tipped with an awl-like point.

The Noble Fir, or "Larch" of the Washington lumbermen, inhabits the Cascades and Coast Range of Washington and Oregon, crossing the California boundary into the Siskiyou Mountains and reaching as far south as Salmon Summit (*W. L. J.*, no. 2079). It was first discovered by David Douglas in 1825 in the Cascades of Oregon near the Columbia River.

## 5. **Abies venusta** Koch.

### Santa Lucia Fir.

Plate 34, figs. 4-6.

Abies venusta Koch, Dendr., vol. 2, pt. 2, p. 210 (1873); Lemmon, 3rd Rep. Cal. Board For., p. 151, t. 17 (1890); Sierra Club Bull., vol. 2, p. 166 (1898); Sargent, Silva N. Am., vol. 12, p. 129, tt. 615, 616 (1898).

*Pinus venusta* Douglas, Comp. Bot. Mag., vol. 2, p. 152 (1836).

*Pinus bracteata* Don, Trans. Linn. Soc., vol. 17, p. 442 (1837); Hook & Arn., Bot. Beechey, p. 394 (1841); Endlicher, Syn. Conif., p. 89 (1847).

*Abies bracteata* Nuttall, Sylva, vol. 3, p. 137, t. 118 (1842); Hooker, Bot. Mag., vol. 79, t. 4740 (1853); Engelmann, Bot. Cal., vol. 2, p. 118 (1880); Kellogg, For. Trees Cal., p. 23 (1882); Veitch, Man. Conif., p. 493, figs. (1900); Eastwood, Erythea, vol. 5, p. 73 (1897).

*Picea bracteata* Loudon, Arb. Britt., vol. 4, p. 2348, fig. 2256 (1838); Lobb, Gard. Chron., (1853), p. 435; Gordon, Pinetum, p. 145 (1858); Lawson, Pinetum Britt., vol. 2, p. 171, t. 25, ill. 26 (1866).

*Taxodium sempervirens* Hooker, Icones, vol. 4, as to t. 379 (1841).

Singular montane tree 30 to 75 or 100 feet high with a narrow crown abruptly tapering above into a steeple-like top; trunk ½ to 2½ feet in diameter, vested in light reddish brown bark and bearing short slender declined or drooping branches often nearly or quite to the ground; leaves stiff and sharp pointed, dark green and flat above, with a white band on either side of the strong median ridge, 1¼ or mostly 1¾ to 2¼ inches long, 1 to 1½ lines wide, mostly 2-ranked; staminate catkins yellowish, fading reddish, broadly cylindrical, ¾ to 1⅛ inches long; ovulate catkins broadly oblong in outline, yellowish green, 1 to 1½ inches long; cones elliptic-oblong, 2½ to 4 inches long, 1½ to 2 inches thick, borne on peduncles 5 to 6 lines long which arise from a rosette-like cluster of broad thin scales of the winter bud; bracts wedge-shaped, truncate or notched at summit, the midribs prolonged into a long-exserted bristle ½ to 1¾ inches long and ½ line wide; seeds reddish brown, 3½ lines long with broad wings 4 to 5 lines long and rounded at apex.

The Santa Lucia Fir inhabits the moist bottoms of cañons and dry rocky summits and is found only in the Santa Lucia Mountains of Monterey County. The local distribution is not well worked out, but it inhabits only the outer or coast ridge, where it occurs, however, on both the eastern and western slopes. The reported localities in order from south to north are as follows: 1. Mountains near Cambria, an indefinitely reported locality, given me by Capt. Olmstead, as also the two following. 2. San Carpoforo Cañon, a good many trees. This cañon is north of Piedras Blancas, on the coast. 3. Villa Cañon, south of Punta Gorda (Cape San Martin), a few trees. Some trees were logged here forty-nine years ago. 4. Bear Cañon, near Punta Gorda, facing east. 5. Cañada

de los Potranchos, east slope, near trail to Los Burros mines. This cañon is wrongly called "San Miguel" in Sargent's Silva, a slip on account of the McGill Ranch in this cañon. 6. Cañon next north of Los Potranchos. 7. Twin Peaks, 4700 feet, and Cone Peak, 5000 feet altitude. These peaks stand in the main axis of the coast ridge and are scarcely more than a mile apart. The San Antonio Trail to the coast from Mission San Antonio passes over the ridge here and descends into the Arroyo Grande. The trees cling to the abrupt eastern side of the peaks, with hundreds and perhaps thousands reaching down into the cañon below, which is on the headwaters of the Nacimiento River. On the western side of the divide they cover the cañon walls pretty well and climb to the very summit of the peaks; even on the south slope of the cañon, in hollows and nooks, there are many trees here and there. The writer crossed the range by this trail in 1901 and believes Twin Peaks to be the locality visited by Coulter, Douglas and Lobb. Douglas estimated the altitude as too great by 1000 feet. 8. Two trees in a gulch on the Santa Lucia Trail have been recorded. 9. On the waters of the Big Sur, in the cañon beyond Post Summit and about a mile or so north of Cold Spring. Reported by Mr. Post. 10. Arroyo Seco near Tassajara Springs, according to H. A. Greene. 11. Headwaters of the Carmel River, according to H. B. Humphrey, the most northerly locality.

The Santa Lucias are extremely broken mountains and are very difficult to travel on account of their steepness and dense chaparral areas. It seems to me a safe presumption that at least as many more localities will be discovered as are now known. But even so, no other fir in the world has so restricted a habitat. Its total range from north to south is scarcely over forty-five miles, covering a strip one mile or less in width. Moreover, it is well isolated geographically. It is not only the only species in the Santa Lucias, but no other species of the genus is found within two hundred and twenty-five miles to the north, one hundred and forty miles to the east and one hundred and twenty miles southeasterly.

It was first discovered in 1831 by Thomas Coulter, a botanical explorer, who in 1832 made the overland journey from Monterey through the South Coast Ranges to Pala Mission and thence across the Colorado Desert to the mouth of the Gila River. On account of the singular character of this fir nearly all of the early botanical explorers following Coulter visited the region, mainly for the purpose of securing seed for cultivation in European arboretums. The list of these includes Douglas, Hartweg, Lobb, Beardsley, and later Kellogg and Brewer.

Long, however, before the coming of these early botanists the Franciscan Fathers at Mission San Antonio knew the trees and called them "Incensio," since from them they obtained the resin used for incense in religious ceremonies in the San Antonio Chapel. Doubtless from them Coulter and Douglas had their information regarding the existence of this species in the rugged and

inaccessible Santa Lucia Mountains well off the old Spanish trail to Los Angeles from Monterey.

In the literature the Santa Lucia Fir is also called Fringe-cone Fir, Silver Fir, Bracted Fir and Bristle-cone Fir. It is remarkable for its slender spire-shaped crowns, its peculiar bristly cones, its large long-pointed winter buds, and its broad sharp-pointed leaves which are alike all over the tree. The cones are borne only in the very summit, and while, of course, erect on the branches, their number and weight bear down the branches so that they seem to hang in dense clusters which are very noticeable and striking.

The branches clothe the axis quite down to the ground and thus form a broad base to the crown. Above, the crown is narrow and simulates remarkably a slender church steeple, the top very attenuate and at a distance reduced to a pencil-like or an awn-like point. So characteristic is their form that one cannot mistake these trees even as far as one may see them. Forming a mere remnant in the Santa Lucias they give to this distinctive mountain range a singular interest and are the quest of botanical travelers from all parts of the scientific world.

## TAXODIACEAE. Redwood Family.

Trees with linear or awl-shaped alternate leaves. Staminate and ovulate catkins on the same tree. Staminate catkins small and cone-like. Scales of the ovulate catkins spirally arranged, more or less blended with the bract, often spreading horizontally from the axis of the cone and developed into broad flattish summits. Ovules to each scale 2 to 9. Seeds not winged or merely margined. Cotyledons 2 to 6.—Seven genera, widely scattered over the earth, each with one to three species. Taxodium (Bald Cypress), Cryptomeria (Japan Cedar), Cunninghamia, and Sciadopitys (Umbrella Pine) are cultivated in California.

### 1. Sequoia Endl.[19] Redwood.

Tall trees with thick red fibrous bark and linear, awl-shaped, or scale-like leaves. Staminate catkins axillary, with many spirally disposed stamens, each bearing 2 to 5 pollen sacs. Ovulate catkins terminal, composed of many spirally arranged scales, each with 5 to 7 ovules at base. Cone woody, its scales divergent at right angles to the axis, widening upward and forming a broad rhomboidal wrinkled summit with a depressed center. Seeds flattened; cotyledons usually 2.

Two living species. In Tertiary times the species of Sequoia were widely distributed over the northerly parts of the earth. Fossil remains of Sequoia have been discovered in many European countries from Italy northward to Spitzbergen, and also in Greenland, mouth of the Mackenzie river, Alaska, Vancouver, and southward along the Pacific Coast to California. From the material thus far uncovered over forty species have been described by palaeontologists but, as might be expected from the fragmentary remains, there is by no means agreement as to the validity of the species, some material being referred even to other genera of the Redwood Family which have living representatives in remote quarters of the earth. Schimpfer in 1903 recognized only twelve species. Aside from the probability that still other species will be brought to light by future exploration, it is certain that the species of Sequoia in the Miocene age of the Tertiary were numerous as compared with the number living today. Several of these extinct species formerly grew on the Pacific Coast. The hills of Corral Hollow in the Mt. Hamilton Range, now arid

[19] Endlicher does not explain the origin of the generic name, but that it was given in honor of the Cherokee Indian, Sequoyah, is accepted by authorities as most highly probable and is at least happily appropriate. Sequoyah, or George Guess, was a talented Indian who invented for his tribe a syllabic alphabet of eighty-three characters, conducted a newspaper in the interests of his tribe, worked successfully in silver and was generally active and prominent.

and treeless, supported *Sequoia angustifolia* in Miocene times, while *Sequoia Heeri* and *Sequoia Langsdorfii* were more or less scattered over Oregon.

KEY TO THE SPECIES.

Leaves linear, petioled, spreading in 2 ranks and forming a flat spray; cones 5/8 to 1 1/8 inches long; Coast Range only ..... 1. *S. sempervirens.*

Leaves awl-shaped, ascending all around stem; cones 2 to 3 3/4 inches long; Sierra Nevada only ..... 2. *S. gigantea.*

## 1. **Sequoia sempervirens** Endl.

REDWOOD.

Plates 36-48, 12.

SEQUOIA SEMPERVIRENS Endlicher, Syn. Con., p. 198 (1847); Bigelow, Pac. R. Rep., vol. 4, pt. 5, p. 23 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 57, 90, fig. 23 (1857); Gordon, Pinetum, p. 303 (1858); Engelmann, Bot. Cal., vol. 2, p. 116 (1880); Kellogg, For. Trees Cal., p. 21 (1882); Somers, Harper's Mag., vol. 79, p. 653 (1889); Purdy, Gard. and For., vol. 3, p. 235 (1890); Lemmon, 3rd Rep. Cal. Board For., p. 163, t. 18 (1890); Gibbons, Erythea, vol. 1, p. 161 (1893); Jepson, Erythea, vol. 4, p. 125 (1896); Shaw, Bot. Gaz., vol. 21, p. 332 (1896); Eastwood, Proc. Cal. Acad., ser. 2, vol. 5, p. 170 (1895); Veitch, Man. Conif., p. 270 (1900); Peirce, Proc. Cal. Acad., 3 ser., Bot., vol. 2, p. 83 (1901); Jepson, Fl. W. Mid. Cal., p. 23 (1901); Shinn, Cycl. Am. Hort., vol. 4, p. 1659 (1902); Lawson, Ann. Bot., vol. 18, p. 1, pl. 1-4 (1904).

*Sequoia gigantea* Endlicher, Syn. Conif., p. 198 (1847); Bentham, Pl. Hartweg., p. 338 (1857).

*Taxodium sempervirens* Lambert, Pinus, vol. 2, p. 24, t. 7 (1824); Loudon, Arb. Britt., vol. 4, p. 2487, figs. (1838); Hooker & Arnott, Bot. Beech., p. 392 (1841); Hartweg, Jour. Hort. Soc. Lond., vol. 2, p. 124 (1847).

*Taxodium* sp., Douglas, Comp. Bot. Mag., vol. 2, p. 150 (1836).

REDWOOD, Nordhoff, N. Cal. Ore. & Sandwich Isl., p. 168 (1877); Sargent, Gard. & For., vol. 10, p. 41 (1897); Fisher, U. S. Bur. For. Bull., no. 38 (1903).

Tall tree 100 to 340 feet in height, with narrow crown, the branches horizontal or sweeping downward, especially the lower ones; bark red and fibrous, 3 inches to 1 foot in thickness; foliage reddish brown; leaves linear, spreading right and left so as to form flat sprays, 1/4 to 1 1/4 (mostly 1/2 to 3/4) inches long and 1 to 1 1/4 lines wide, or in the top of adult trees with short linear or awl-shaped leaves 1 to 4 or 5 lines long and strikingly similar to those of the Big Tree; staminate catkins 3 lines long, with ovate crests and 4 pollen-sacs; cones oval, reddish brown, 5/8 to 1 1/8 inches long and 5/8 to 7/8 inch broad, borne in clusters on the ends of branchlets mostly in the top of the tree, maturing in first autumn; scales 14 to 26; seeds narrowly margined, elliptic in outline, 2 lines long.

The Redwood, or Palo Colorado of the Spanish-Californians, is an inhabitant of the humid coast region of California from the southwestern corner of

Oregon to Monterey County and thus is confined mostly to a narrow strip four hundred and fifty miles in length and averaging twenty miles in width which is called the Redwood Belt. In the belt proper the trees grow on the slopes of cañons and river flats of streams belonging to the outer or seaward Coast Range facing the ocean. Throughout the belt the Redwood is commonly the dominant tree but is usually associated on the slopes with Douglas Fir, Lowland Fir, Coast Hemlock, and Tan Oak; on the flats or river benches it forms a pure stand, crowding out all other species.[20] As one ascends to the heads of cañons or crosses the divides, the Redwoods diminish in number and are replaced by increasing numbers of Douglas Fir, Tan Oak, and Madroña. The altitudinal range is from near sea-level to about 3000 feet. The most northerly locality for this species is in Curry County, Oregon, on the Chetco River about four miles from the coast and about eight miles north of the California State line. Here there is an isolated grove. The only other grove in Oregon is in the same county on the Winchuck River very near the California boundary. There are four hundred acres in these two groves.

The main Redwood body occurs in a belt which begins in Del Norte County on Smith River and extends southward through Humboldt and Mendocino counties to southern Sonoma. This "belt" is continuous save for a transverse break at the headwaters of the Mattole River a little south of Cape Mendocino. Southward the Redwood occurs in the deep cañons of southern Marin and forms an important part of the forest on the western slopes of the Santa Cruz Mountains. The main "Redwood Belt" in these mountains extends from the San Mateo line nearly to the Pajaro Valley, a distance of twenty-five miles with an average width of eight miles, but small clusters or scattered trees range beyond these limits particularly in San Mateo County. The "Big Basin" of this region is a mixed woodland of Redwood, Douglas Fir, Tan Oak, and Madroña which is preserved as the property of the State under the name of the "California Redwood Park." This reservation contains 3800 acres, 1500 acres being dense timber, 1000 acres thin timber, and 1300 acres brush or logged land. It was secured for preservation in a wild state chiefly through the efforts of the Sempervirens Club and especially Professor W. R. Dudley of Stanford University. The "Santa Cruz Big Trees" is a Redwood grove on San Lorenzo River at Felton; on account of the size of the trees and their accessibility they have long been objects of popular interest. Fair-sized trees mark for many miles the crest of the Santa Cruz ridge and a small number descend sheltered cañons of the eastern slope within a few hundred feet of the Santa Clara Valley level. They have also crossed the Pajaro River to the south bank where they form a small colony near Chittenden, the only Redwoods in San Benito County.

[20] See plate 37.

Between the Santa Cruz Mountains and the Santa Lucia Mountains is a low, flat or nearly flat region at the mouth of the Salinas River and about Monterey where the Redwood does not grow. Its total absence here is due partly to soil conditions, partly to the increased summer heat, and partly to the decreased precipitation. Monterey has an average of but fifteen inches of rain. I know of no station of so little rainfall which supports Redwood except possibly in the Santa Lucias. No rainfall records are, however, available for that mountain range and in any event the local habitats are peculiar as will next be shown.

In the Santa Lucia Mountains the scattered remnants of the Redwood are confined, on account of the excessive aridity of the region in general, to the cañons cut out of the abrupt western slope overhanging the ocean. These cañons run down to the sea with impressive directness and they are so deep and often so narrow that the upper branches of Redwoods standing in their bottoms will touch or nearly touch the cañon walls on either hand. In such places the trees are exceedingly well protected, although some of them climb also to the heads of gullies where there are at least half-year springs. (Plate 38.)

The Santa Lucias belong mainly to the upper Sonoran Zone with the chaparral everywhere very prominent, while the upper Transition or Redwood is in the form of narrow tongues thrust under this zone on the western side. The characteristic forest species of these two zones impinge in particular localities very closely. Not elsewhere can the behavior of the Redwood under untoward conditions be studied to such advantage. Here in this range is the only place where the Redwood and Sycamore can be found within the same half-acre as in the river bottom of the Big Sur. Here too Big-cone Pine (*Pinus Coulteri*) approaches within two hundred yards of Redwood trees in heads of cañons, and Black Cottonwood (*Populus trichocarpa*) is found growing with them in stream beds. The amount of rainfall is really insufficient for the Redwood (therefore the rain factor favors the shrubs of the chaparral and other Sonoran species), but it has compensations in the prevailing summer fogs, in its positions in stream beds, or on the steep north walls of cañons where it is partly protected from the summer sun, or in swales at the heads of gulches where there is more or less water seepage. The conditions are on the whole so unfavorable that the stand is thin; scattered or isolated trees are far more common than in the north and consequently are more individual. Mature trees with very long branches, broad or irregular crowns, or with a flat crown like a broad, flat hat are a feature of this country. In cañon bottoms, on the contrary, trees four to ten feet in diameter and one hundred and fifty feet high are not uncommon. The distribution in the range is from Tobie Dow's Ranch on Rock Creek to a point twelve miles south of Punta Gorda (Cape San Martin), where the trees are in a gulch just north of Salmon Creek Cañon. This latter

locality marks the southernmost station. There are no Redwoods in San Luis Obispo County. Certain species characteristically associated with the Redwood in the north are also found in the Santa Lucias. They are as follows: Madroña (*Arbutus Menziesii*), Tan Oak (*Pasania densiflora*), Blue Blossom (*Ceanothus thrysiflorus*), Thimble-berry (*Rubus Nutkanus*), Redwood Sorrel (*Oxalis oregana*), and Coltsfoot (*Petasites palmata*).

The Redwood reaches its greatest development in Humboldt and Del Norte counties, especially on the bottom lands of Smith River and the main Eel. Along either of these streams one may at the present day drive for twenty miles through virgin forests where the trees completely monopolize the alluvial benches and are of uniformly large size and where stands of 125 to 150 thousand feet, board measure, to the acre are not uncommon.[21] These are said to be the heaviest stands of timber in the world. Instances of 2½ million feet to one acre are on record,[22] while 480 thousand feet, not including waste, has been taken out of a single tree. Along the south fork of the Eel the Redwood Belt leaves the coast and dips inland opposite Cape Mendocino until touching the coast line again in southern Humboldt. The seaward hills are here very barren. The winds from the ocean strike them with great violence and control the crowns of Alder and Laurel following water courses in cañons as if their tops were cut squarely off. Cape Mendocino is not an especially imposing promontory but it is a sign of great influence on both sea and land.

In Mendocino the Redwood occurs as far east as Willits and the Russian River. In the Sonoma region it is not abundant save on the seaward slopes but is widely distributed, ranging eastward to cañons in the Mt. Hood Range on the western side of Napa Valley, even reappearing on the eastern slopes of Howell Mountain in the Napa Range and descending that mountain nearly to the level of Pope Valley which is on the basin of a tributary of the Sacramento River and belongs in the catalogue of hot and dry interior valleys.

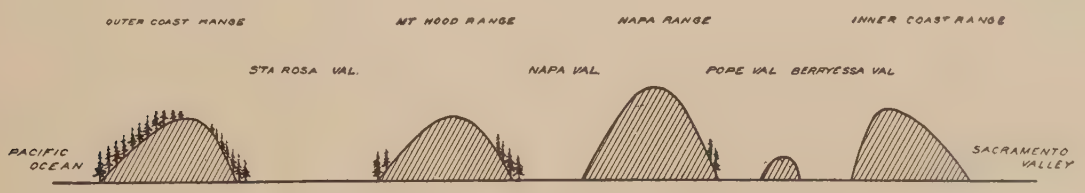


Fig. 10. Diagramatic east and west cross-section of the North Coast Ranges in neighborhood of Mt. St. Helena, showing occurrence of the Redwood in three of the four successive ranges from the Pacific Ocean eastward to the Sacramento Valley.

[21] See plate 39.

[22] These figures refer to standing timber and were published by the Redwood Lumber Manufacturers' Association ("The Home of the Redwood," pp. 28, 29). Figures given by Eckbo (For. Quar., vol. 7, p. 139) are not so imposing: "Many claims of 160 acres will yield 40,000,000 feet, and certain acres have yielded as much as 1,300,000 feet. One tree . . . yielded over 165,000 feet tallied from the saw."

This is a most remarkable station, for not elsewhere does the Redwood occur on the waters of the Sacramento or any other interior stream. It is here that the Redwood is found at greatest distance from the ocean; it is here that a curved tongue-like area of high rainfall reaches eastward from the coast toward the summit of the Vaca Mountains; and it is here that the ocean fogs penetrate inland with greatest persistence during the summer. Redwood thus occurs in three successive and parallel mountain ranges, being most common on the western slopes of the first or seaward range and the eastward slopes of the two inner ranges. (Fig. 10.) In the Mt. Diablo Range it occurs nowhere except on Redwood Peak in the Oakland Hills, the giant trees which formerly crowned that crest serving in early days as guide marks to vessels entering the Golden Gate.

The Redwood Belt is as distinctively marked by its physical and climatic characteristics as it is by the presence of Redwood trees. It is distinguished as a region of high rainfall in the rainy season, of prevailing fogs in the dry season, and of slight change of temperature during each day and during the year. On the other hand the moisture conditions for the Big Tree of the Sierras vary greatly during the year, while the daily and seasonal variation in temperature is very much greater than in the case of the Redwood.

The main portion of the "Redwood Belt" from Sonoma County to Del Norte County receives on the coast line a seasonal average of 50 inches of rain. This average is doubtless higher in the extreme north (as at Crescent City, which had in the season of 1903-04 a total of 107 inches), and also inland towards the summits of the mountains. Southward the average decreases rapidly, being 27 inches at Santa Cruz and 15 inches at Monterey. The number of foggy days in the summer months is twice greater than in the winter months and the actual number of foggy days in the dry season is probably greater in the south than in the north. Summer fogs not only provide a humid atmosphere but the fog particles are mechanically collected by the towering columns of foliage and precipitated in the form of gentle rain. Wagon trails which have become uncomfortably dusty during the day are thus offered to the traveler the next morning as delightful driveways. The greatest rainfall in this region is from December to March. During this period the rain may fall continuously for days and even weeks and yet the streams will only rise slightly and with the utmost deliberation. This is on account of the heavy litter of foliage on the forest floor and the dense undergrowth of shrubs, bushes, flowering herbs and ferns which form a dense tangle everywhere in typical Redwood country.

The age of adult Coast Redwood varies from 400 to 1300 years. It is possible that some of the largest trees may equal the highest definite ages determined for the Big Tree. The two species, however, differ in rapidity of

growth, the Redwood very much exceeding the Big Tree. For thirty or forty years or more Redwood grows in height at the rate of two feet per year. When between four and ten years it may grow two feet to six feet and six inches in height per year.

Reproduction is by means of seeds and stump sprouts. While seeds are produced in enormous quantities seedlings are a great rarity in the Redwood Belt, the densely shaded forest and the ground litter of foliage, often one foot thick, offering most unfavorable conditions for germination. Moreover a large percentage, 60 to 75 per cent., of the seeds are not viable. On the other hand *Sequoia sempervirens* reproduces by stump sprouts with remarkable persistence. It is the only strictly coniferous species which has this habit. The tree has no tap-root but a large number of huge lateral roots which lie near the surface of the ground at their point of origin, a most advantageous position to generate by adventitious buds a circle of sprouts about the stump. The sprouts are usually numerous, sometimes a hundred or more. These form a second generation[23] which, reduced in number by competition, are eventually represented by a circle of trees. In some instances these trees have been cut and a third generation is now near to merchantable timber. Such "circles" may be seen in Mill Valley at the southeastern base of Mt. Tamalpais. One of these "circles" is fifty-one feet in one direction, forty-five feet in the other direction, and contains forty-five large trees, not counting small ones. The girth of the trunks ranges from less than two to six feet while the crowns rise fifty to seventy feet. In the centre once stood the parent; the stumps represent the second generation, while the living trees are of the third generation at least. In this perfectly shaded circle divine services were at one time held and it is safe to say that two hundred and fifty people could be comfortably seated within this natural enclosure. Circles resulting from the death of aged trees are also found in virgin forests. In most cases the original stump has wholly disappeared as a result of repeated fires and we have the shallow tree-encircled hollows which the woodsmen call "goose nests."

Fire is universally used throughout the Redwood Belt by the lumber companies to clear away the tangle of tops, young trees and bushes, and facilitate the getting out of logs. The scene in a logged and therefore burned over district, bristling with scattered standing trees or "culls" and cumbered with down timber, is one of almost terrifying desolation.[24] The surface soil has become thoroughly sterilized and the sharp slopes exhibit marked and unusual erosion. With such a dismal outlook one is not prepared for the recovery wrought by the trees in two or three seasons or even one season until one considers their constitutional vigor and resistance to fire. The wood contains so little resin

[23] See plate 40, fig. 2, and plate 42, illustrating second and third generations.

[24] See plate 40, fig. 1.

that it is commonly assumed to have none and the bark burns reluctantly and very slowly. Blackened charred stumps in two or three seasons are hidden from view by numberless sprouts; standing columns of one hundred to two hundred feet clothe the shaft with a layer of foliage two or three feet thick.[25] The spreading limbs, fire-killed, and with sapwood uncovered by the loosened bark, protrude white and skeleton-wise, through the coat of soft green stuff until they eventually fall. Even large trees excessively burned, with the heart-wood eaten out until they become roaring chimneys one hundred and fifty feet high, produce scattered patches of green leaves. The reserve force, the rejuvenating power of the Redwood in opposition to the power of fire, to the drying out of the forest by the summer suns, and to the eroding effects of winter rains is probably not surpassed by any other tree. It is only in the southern parts of the range and on unprotected slopes where the balance of conditions is exceedingly nice and therefore easily disturbed that the stumps die after logging. On logged areas in the river bottoms of the Eel and Van Duzen, stumps in land desired for farming can be and are killed by firing repeated at short intervals, but even though the stumps are thus killed it is difficult to clear them off the land. It is impracticable to burn them out and they cannot be removed by stump-pullers or even donkey-engines save with great difficulty. They seem almost indestructible. Now that lumber is becoming scarcer stumps in some old fields are being sawn into shingles.

The incredible vitality of the Redwood is further exampled by recently felled logs in the forest which often throw out new shoots from their trunks. Cut off from communication with the roots these green sprays soon die, but are illustrative of the promptness and blind energy with which the tree attempts to overcome disaster. It is also singularly free from attacks by insects or by disease. The brown rot sometimes forms "pockets" in the periphery of the trunk, but is so uncommon as to be of little moment, while the damage by injurious insects is very slight.

The wood of the Redwood is light, soft, very straight-grained, not tough but fairly strong relatively to its lightness and singularly durable. It is red in the heartwood and white in the sapwood, which is two to five inches thick. All mechanics agree that it works easily, takes a beautiful polish, and holds its shape well. Its good qualities have only been gradually discovered and recognized. In "gold days" and for many years following, when timber for building purposes was exceedingly scarce, Redwood was regarded with great disfavor. It was looked upon as being next to worthless on account of its softness, lightness and lack of strength. Houses were brought "around the Horn" from New England and New York and set up in San Francisco and Oakland within five to fifteen miles of Redwood forests. What is more remarkable, a house of similar

[25] See plate 41.

origin was taken to Trinidad, in the heart of the northern Redwoods, where for many years it was a landmark until destroyed by fire. Doubtless prejudice was strengthened by the inaccessibility of the trees. The entire coast between Point Reyes and Humboldt Bay is rockbound and has no real harbors, while the trees themselves grow among rugged mountains. As time went by its cheapness brought Redwood into general use, although regarded as an inferior or substitute wood. But in these days the wood is coming into its own. As its qualities are revealed and methods of working or treating it become known, a wider and still wider field of usefulness will enlarge the Redwood market. It is used for posts, farm-buildings, exterior and interior finish of houses, shingles, water-tanks, wine-vats, telephone poles, railroad ties, piles, siding and roofing for freight cars, blocks for street-paving, pipe-lines for irrigation and for conducting water to electric power plants. Nowadays the output of redwood doors is very great, but when first manufactured they "could scarcely be given away." In some particulars they have superior points. As outside doors their life is longer than pine doors since they will not twist or warp as do the latter. Durability of the wood in contact with soil is a strong recommendation for many purposes. Posts which have been in the ground for thirty or forty years are in some cases good for another decade. The rather rare "Black Redwood" is from trees in which the heart-wood is dark-red and close-grained; it is very resistant to decay and is especially sought for the construction of tanning vats which set below the surface of the ground. Redwood is, as a rule, very soft and spongy, characteristics which are of the utmost importance in certain kinds of construction. Although San Francisco has a dry climate and is a city of frame houses, it never had a general and widespread conflagration until April, 1906, when the water supply was suddenly and absolutely cut off by earthquake disturbance. This immunity from fire was due to the fact that most of the houses were built of Redwood. As a protection against fire the wood has two superior qualities; it does not ignite readily, burning slowly at first, and it is so spongy that it absorbs a stream of water from a fire-hose with marked avidity. In the construction of pipe lines Redwood is rapidly coming into favor and in one case has replaced steel to the disadvantage of the latter. The grit in the rushing water rapidly wears out the steel, while in the case of the former the quality of the wood is such that a scum is formed on the surface which furnishes it protection.

The finest quality of Redwood comes from the Humboldt forests and uniformly commands a higher price in the market than the Mendocino product. Its grain is very soft and silky and it is especially valued for the interior finish of houses, the best results being obtained by using the "natural wood" or by filling and staining to secure an ebonized effect. "Flinty" trees, yielding harder and less straight-grained wood, while found in the Humboldt forests as well, occur

in greater numbers southward. "Curly Redwood" is wavy or knotted-grained wood chiefly from the stump of the tree and is highly valued for ornamental purposes. "Burly Redwood" is a wood of complex grain furnishing beautiful cabinet patterns; it is derived from large abnormal growths on main trunk which are of occasional occurrence.

On protected land second-growth Redwood can be profitably milled thirty to thirty-three years after first cutting. Timber ten inches at the butt is at the present time being cut into lumber in Santa Cruz County. Lumber stacks in that district, streaked red and white, are in pointed contrast to the northern yards where the white sap-wood is universally rejected.

Stumps on logged lands, especially in old cuttings on river bottoms, are often six to twelve feet high. Cuts were made well up the tree for two reasons: the wood of the stump is regarded as of inferior quality, and the bulge of trunk near the ground is so great that the choppers went up the tree and stood on a spring board above the swollen base as a matter of economy of labor in getting the tree down. Nowadays the axe plays a subsidiary role. The "fallers," who work in pairs, first chop a notch on one side of the tree. This is the "undercut" and determines the direction of fall, a matter in which experienced woodsmen acquire great skill. The trunk is now sawed through from the opposite side ("sawcut"), iron wedges being driven in to prevent the column from settling down and biting the saw. The driving of the wedges also influences the direction of the fall. (Plates 43 and 44.)

It is a prime object, as in all woods work, to land the tree on the ground with a minimum of breakage in the main shaft. On sharp slopes trees are for this reason felled up hill. The trunks are sawed into 12 to 24-foot lengths or logs by "sawyers" either before or after the bark is removed by "peelers" and then beveled or "nosed" at one end to facilitate sliding along the ground or over the "skid roads" made of small timber laid crosswise of the trail. After the tangle of tops, cull trees and brush are "cleared" by fire, the logs are hauled down hill by steel cables, wound up on drums attached to donkey engines, made up into "trains" which are pulled to the logging road by a more powerful stationary engine known as a "bull donkey," and finally loaded on the cars of the logging road and taken down to the mill (usually situated on the coast) and stored in a mill pond. While the wood is exceedingly light when dry it is very heavy when "green" and full of sap. The first log cut from the base of the trunk and also the second may be so heavy that it will not float and must be buoyed between two lighter logs. Such logs are called "sinkers." The great size of Redwood logs has necessitated the development of special methods and machinery in handling. Since modern methods in logging and mill work in the Redwood district have always led other districts in this State in elaborate and powerful contrivances, and especially in labor-saving devices, it is for this reason that a very brief

sketch of the Redwood logging industry has found a place in this paper. (Plates 45, 46, 47, 48.)

The loading of Redwood on vessels on the Mendocino coast is a picturesque although difficult operation. There are no harbors and the ships are held in the open roadsteads by lines attached to anchored buoys. The lumber is carried from the shore to the vessel in "baskets" which run on a steel cable. Loading is mostly confined to periods of pleasant weather since in case of a storm the vessel must stand out to sea. Wharves to which the vessel is tied up have been more recently built at some important shipping points.

At first almost despised, Redwood has come into a position of vast economic importance in later years. The annual product in 1905 was 411,689,000 feet BM. At the present rate of cutting the last of the virgin forests will be milled within forty-five years as near as can be estimated, but a forecast of this sort is subject to great uncertainty on account of the probability of increasing demand and of the certain exploitation of the belt that will follow the completion of railroad lines now building towards Eureka.

Practically the whole Redwood Belt is under private ownership and will inevitably be lumbered. Two areas have been set aside as public parks, the California Redwood Park, owned by the State, and the Muir Woods, the gift of William Kent to the Nation. The latter consists of 295 acres lying on the south side of Mt. Tamalpais and long known as Redwood Cañon. The usefulness of these reservations to the public will rapidly increase with each decade as the wild, free parts of California are modified and restricted by civilization, and the satisfaction of our Commonwealth in the future in these possessions can scarcely be predicted at the present time. Muir Woods is an especially fortunate acquisition, since it lies within one hour's journey of San Francisco and is accessible by a very short ride to half the population of California. The Bohemian Club Grove is a private reservation on the Russian River in Sonoma County which will undoubtedly be preserved indefinitely in its present state.

Many citizens of the State very earnestly desire that the Armstrong Grove on the Russian River be acquired for permanent public use. A bill for this purpose passed both branches of the California legislature in 1909 but failed of executive approval. The author is heartily in sympathy with the proposal to preserve the Armstrong Grove but he is not in sympathy with the too obvious tendency of towns and communities hastening to the capital of the State or to the capital of the Nation and asking the State or Nation to do for them the things which they might well do for themselves. Such a policy will inevitably lead to local helplessness and be followed by decay.

The finest development of the Redwood in point of density of stand and size of trees occurs in Humboldt and Del Norte counties where it is still to be found in great primitive tracts, as yet wholly untouched by the axe. The preservation

in primitive condition of at least a small area, even if no more than one or two sections, along Eel or Smith rivers as a natural wonder-park would be, aside from esthetic or scientific reasons, of many-fold greater money-value to the Eureka or Crescent City communities than the conversion of this area into lumber. It is to be hoped that some lumber company of the north may be impelled to select a beautifully situated grove for the perpetual and finer uses of the community.

The Redwood was first collected near Monterey by Thaddeus Haenke of the Malaspina Expedition in 1791, who may be said to be its botanical discoverer. The second collector was Archibald Menzies of the Vancouver Expedition,[26] from whose specimens Lambert, the English botanist, taking the tree to be of the same genus as the Bald Cypress, published it in 1824 as *Taxodium sempervirens.* A transcript of Lambert's description is here given:

"Taxodium sempervirens

Evergreen Taxodium

Taxodium Sempervirens, foliis distichis linearibus acutis perennantibus coriaceis glabris opacis. Habitat in Orâ occidentali Americæ borealis. *Menzies.*

Descriptio.

Arbor sempervirens. Ramuli angulati, folioso, glabri. Folia lineari, acuta, disticha, coriacea, glabra utrinque opaca, lucida, subtus nervo medio carinata, margine plana, semi vel nunc fere pollicem longa, semilineam lata, basa decursiva. Galbuli terminales solitarii, subrotundi, basi squamis brevibus imbricatis muniti; squamis trapezoideis, peltatis, crassis, fungosolignosis, supra rugosis, atque radiatim striatis, centro depressis, basi in pedicellum crassum angulatum desinentibus. Semina ad singulam squamam numerosa, angulata, gilva.

"Having only a single imperfect specimen of this species for examination, it is not without some hesitation, that I have referred it to Taxodium. I have thought the plant too interesting, however, to omit in the present work, leaving to future observations to determine, whether or not the place I have assigned to it be correct.

"The tree appears intermediate between Taxodium and Cupressus, agreeing with the latter in the indefinite number of the seeds. The late Mr. Salisbury considered it as forming a new genus, and had applied to it the name Condylocarpus.

"This plant I propose to call sempervirens, from its evergreen leaves, so different from the Taxodium distichum, whose leaves are deciduous.

"I have been enabled to give the accompanying figure from a specimen obligingly communicated to me by my friend Mr. Menzies, who collected it on the Northwest Coast of America during the voyage of the celebrated Vancouver."—A Description of the Genus Pinus. By Aylmer Bourke Lambert. London. 1832 edition.

No exact locality has ever been given for the Menzies collection, but while examining Menzies' original specimen at the British Natural History Museum in London I turned over the sheet and discovered written on the back "Santa Cruz, *Menzies.*"

The botanical explorer, Douglas, referred it to the same genus as Lambert; travelling through the Santa Cruz forests in 1830, he wrote to Dr. Hooker in

[26] The Vancouver Expedition touched Monterey first in 1792.

England that "the great beauty of California vegetation is a species of Taxodium, which gives the mountains a most peculiar, I was almost going to say awful appearance—something that plainly tells that we are not in Europe." It was not until 1847 that Endlicher founded the distinct genus Sequoia and created the binomial *Sequoia sempervirens.*

Redwood has been cultivated in England since 1846 and is now found in gardens throughout southern Europe. It is only in recent years that Redwood for ornamental planting has become popular in California. Several horticultural varieties have been originated, differing in hue of foliage or hang of branchlets from the typical form. The variety *adpressa* Carr. has short rigid branchlets. In addition there are the varieties *gracilis* Carr., *taxifolia* Carr., *picta* Sudw., and *glauca* Gord. Glaucous or silver-leaved forms as well as lustrous-leaved forms exist in the primitive forest. A cluster of four Silver Redwood trees stands in Mill Creek Cañon in the Big Sur country of Monterey County. They are very striking objects as seen from the mountain grade leading to Posts.

### **Sequoia gigantea** Dec.

BIG TREE.

Plates 49, 50, 4.

SEQUOIA GIGANTEA Decaisne, Bull. Soc. Bot. Fr., vol. 1, p. 70 (1854); Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 140 (1856); Bloomer, Proc. Cal. Acad., vol. 3, p. 399 (1868); Engelmann, Bot. Cal., vol. 2, p. 117 (1880); Kellogg, For. Trees Cal., p. 19 (1882); Shinn, Gard. & For., vol. 2, p. 614 (1889); Walker, Zoe, vol. 1, p. 198 (1890); Lemmon, 3rd Rep. Cal. Board For., p. 165, t. 19 and Frontisp. (1890); Coville, Bot. Death Val., p. 224 (1893); Eisen, Zoe, vol. 4, p. 141 (1893); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 526, pl. 99B, 102 (1900); Muir, Mountains of Cal., p. 179 (1894), Our Nat'l Parks, p. 268 (1901).

*Wellingtonia gigantea* Lindley, Gard. Chron., 1853, p. 823; Hooker, Bot. Mag., vol. 80, tt. 4777, 4778 (1854); Bigelow, Pac. R. Rep., vol. 4, pt. 5, p. 22 (1856); Gordon, Pinetum, p. 330 (1858).

*Sequoia Wellingtonia* Seeman, Bonplandia, vol. 3, p. 27 (1855); Sargent, Silva N. Am., vol. 10, p. 145, t. 536 (1896); Veitch, Man. Conif., p. 274 (1900).

*Taxodium giganteum* Kellogg & Behr., Proc. Cal. Acad., vol. 1, p. 53 (1855).

*Taxodium Washingtonianum* Winslow, Cal. Farmer, Sept., 1854.

*Sequoia Washingtonia* Sudworth, U. S. Div. For. Bull. no. 17, p. 28 (1898); Sierra Club Bull., vol. 2, p. 171, pl. 24 (1898).

MAMMOTH TREES, Williamson, Pac. R. Rep., vol. 5, p. 257, pl. 13 (1856).

BIG TREE, Gray, Am. Jour. Sci., 2d ser., vol. 17, p. 440 (1854), Proc. Am. Acad., vol. 3, p. 94 (1857); Anon., U. S. Div. For. Bull., no. 28 (1900).

Giant tree 150 to 325 feet high, with columns 80 to 225 feet to the first limb and 5 to 30 feet in diameter at 6 feet above the ground; crown rounded at summit or much broken in age; bark red, deeply furrowed or fluted, ½ to 2 feet thick; leaves awl-like, 1 to 6 lines long, only the tips free, adherent below to the

stem which they thickly clothe; cones maturing in the second autumn, red-brown, ovoid, 2 to 3¾ inches long, composed of 35 to 40 scales; scales with transversely rhomboidal summits and a centrally depressed umbo; seeds numerous; flattened, margined all around with a wing, ovatish or oblong in outline, 2½ to 3 lines long.

The Big Tree inhabits the western slope of the Sierra Nevada from Placer County to Tulare County, a longitudinal range of two hundred and fifty miles. While always mixed with other species of coniferous trees in the main forest belt of the Sierra such as the Sugar Pine, White Fir, Incense Cedar and Yellow Pine, it is, nevertheless, mostly restricted to very definite localities of limited extent which are called "groves" and in which, either by reason of number or size of individuals, it is the dominant type.

The groves which occupy locally favorable or protected spots where the soil is rich, deep and moist, are few in number and very much isolated except south of Kings River, where the trees become much more numerous and more widely scattered through the forest. (See Maps 1 and 2.) The Big Trees are so numerous in the basins of the Kings, Kaweah and Tulare rivers that they may be said to form, in that region, an interrupted belt. In the north the groves are found at altitudes varying from 4700 to 5800 feet and in the south from 5000 to 7500 feet. It is a region where the average annual rainfall is 45 to 60 inches, where the snow becomes two to ten feet deep and lies on the ground three to six months in the year, and where the temperature in winter often falls to zero.[27]

The North Grove of Placer County, made known in 1893 by Mr. W. W. Price, is a "grove" only by courtesy, containing but six trees, although interesting as the most isolated and most northerly station.

The Calaveras Grove of Calaveras County was the first discovered, and is the best known. It contains 101 living trees, besides several fallen ones, one of which is hollowed by fire and is so huge that a mounted horseman may ride through it. The famous dancing pavilion was built on the stump of the tree cut in 1854. The living trees are of uniformly large size and splendid proportions. Pilgrims from all parts of the world have journeyed to this temple of the Sequoias since the early years of its discovery. A great deal of the folk-lore which has gathered about the trees in the Calaveras Grove may be found in Hutching's "Heart of the Sierras." As long ago as 1869 the annual number of visitors to the grove was about two thousand. The trunks are marked with little marble slabs bear-

[27] Rainfall and temperature records at Big Tree stations are very scarce. The following are records made in the General Grant Grove by L. L. Davis, U. S. Park Ranger:

| October 1-July 1 | Minimum Temp. | Snowfall | Greatest Depth Snow at one time | Rainfall |
|---|---|---|---|---|
| 1905-6 | —2° | 197 inches | 9 feet | 31¾ inches |
| 1906-7 | 0° | 202 inches | 9½ feet | 15½ inches |
| 1907-8 | 6° | 117 inches | 5⅚ feet | 10½ inches |

The coldest winter experienced was that of 1902-3, when the mercury fell to —9°. The rainfall record does not include the melted snow.

ing the names of people of note, or of States, although some of the trees are named from some quality suggested by the tree itself. The naming of the trees after favorite generals or statesmen, so characteristic of civilized society, contributes nothing to a poetic understanding of these primeval trees, although of some scientific advantage in that measurements have been precisely referred to definite trees. In one hundred to three hundred years, however, most of the names will mean nothing to the curious passer-by. The trees will easily outlive the names attached to them.

The Stanislaus Grove, also called the South Grove, is situated about six miles southeast of the Calaveras Grove on a divide between Beaver and Griswold creeks, tributaries of the Stanislaus River. It contains 1380 trees scattered over about a thousand acres.

The Tuolumne Grove is situated seven miles beyond Crockers Station on the Big Oak Flat road at an altitude of 5800 feet. There are about thirty trees in this group. An opening has been cut through the stump of a dead tree for the passage of Yosemite stage coaches.

The Merced Grove is located in a sheltered cañon on a branch of the Merced River three miles beyond Hazel Green. The Coulterville road to Yosemite passes through the grove, which contains thirty-three trees.

The Mariposa Grove really consists of two groves, occupying a little depression on the ridge between the South Merced and Big Creek. There are 365 trees in the upper grove and 182 in the lower grove, both groves being included within the Yosemite National Park, and known as "Mariposa Big Tree Grove." The largest tree is the Grizzly Giant, made famous by photographs, which, according to Whitney's measurements, is ninety-three feet seven inches in circumference at the ground and sixty-four feet three inches at eleven feet above.

The Fresno Grove is situated about ten miles from the Mariposa Grove in a southwesterly direction on the undulating country between Big Creek and Fresno Creek and contains over five hundred trees scattered over as many acres.

The Dinkey Grove, at times called the McKinley Grove, occupies a cañon opening on to Dinkey Creek, a tributary of Kings River, and contains seventy-five trees. It is fourteen miles east of Pine Ridge in Fresno County and within the limits of the Sierra Forest Reserve. It is, too, the most southerly of the eight isolated groves and is one hundred and seventy miles distant from the North Grove.

The Big Trees are so numerous in the basin of the Kings, Kaweah and Tule rivers that, as indicated above, they form an interrupted belt. In the Kings River country they are scattered through the forest on the south side of the South Fork of Kings River on the basins of Mill Creek, Old Mill Creek and other streams. The actual acreage of these groves averages two to three adult

trees per acre. The Boole Tree, one of the large standing trees, is about two miles easterly from the "New Mill"; it is one hundred and nine feet and eight inches around the base on slanting ground and seventy-seven feet in circumference at ten feet above the ground.[28]

The General Grant National Park, two miles square, protects several hundred exceedingly large trees and is set in the midst of the Kings River groves. A fallen log in the grove has been so hollowed by fire that a horseman may ride through it from end to end, 125 feet. The General Grant tree is one hundred and seven feet four inches around at ground and about sixty-nine feet around (twenty-three feet in diameter) at twelve feet above the ground.

In the Kaweah River basin there are extensive groves on all of its five forks —the North Fork, Marble Fork, Middle Fork, East Fork and South Fork. All of these groves, excepting those of the North and South Forks and the lower groves of the East Fork, are within the boundaries of the Sequoia National Park, which covers an area of about two hundred and fifty square miles. The groves on the Marble Fork give name to the "Giant Forest," which is situated on a plateau three or four miles square between the Marble Fork and the Middle Fork at an average altitude of 6300 feet. While the Big Tree is here most numerous about springy meadows,[29] it is also scattered throughout the forest in deep soils and a few giant individuals even stand on the exposed granite floors of some parts of the plateau. It is estimated that the Giant Forest contains five thousand large-sized Big Trees. The largest tree is the General Sherman, the trunk one hundred and three feet around at the ground and eighty-two feet and four inches at twelve feet above the ground; it is two hundred and eighty feet high. The tallest tree reported is three hundred and nineteen feet high (Fry and Welch). The number and beauty of the Sequoias, the variety and size of the associated conifers, the primitive conditions of the woodland, the elevated table-land protected by snowy Sierra peaks and set off by yawning cañons are features of the Giant Forest, which is not equaled by any other American forest in interest and grandeur.

The basin of Tule River contains several groves, and there are also groves across the divide from the East Fork of the Middle Tule on Freeman Creek and other tributaries of Kern River. The most southerly locality for the Big Tree is the headwaters of Deer Creek, the stream next south of Tule River, where there are several square miles dotted with trees.

[28] In view of the controversy regarding the size of the trunk of this tree, it may be stated these measurements were made by the author with the assistance of Mr. Ralph Hopping.

[29] See plate 4.

## TABLE OF BIG TREE GROVES AND FORESTS.

Maps 1 and 2.

### North Groves.

| | Name of Grove | Location | Area Acres | Altitude | No. of Trees |
|---|---|---|---|---|---|
| 1. | North Grove | Middle Fork American River, Placer Co. | 5 | 4300–5000 | 6 |
| 2. | Calaveras Grove | Stanislaus R., Calaveras Co. | 51 | 4800 | 101 |
| 3. | Stanislaus Grove | Stanislaus R., Tuolumne Co. | 1000 | 5000 | 1380 |
| 4. | Tuolumne Grove | Merced-Tuolumne Divide, Tuolumne Co. | 10 | 5800 | 30 |
| 5. | Merced Grove | Merced-Tuolumne Divide, Mariposa Co. | 20 | 5500 | 60 |
| 6. | Mariposa Grove | South Fork Merced R., Mariposa Co. | 125 | 6000 | 365<br>182 |
| 7. | Fresno Grove | Headwaters Fresno R., Madera Co. | 2500 | 5000 | 1000 |

### South Groves.

| | | | | | |
|---|---|---|---|---|---|
| 8. | Dinkey Grove | Dinkey Cr., Fresno Co. | 6 | 5000 | 75 |
| 9. | Converse Basin Forest | South Fork Kings R., Fresno Co. | 5000 | 5000–7000 | 12,000 |
| 10. | Boulder Creek Forest[1] | Boulder Cr., South Fork Kings R., Fresno Co. | 3200 | 6000–8000 | 6450 |
| 11. | General Grant Forest | Gen. Grant Nat. Park, Fresno and Tulare Cos. | 2000–3000 | 6500–7000 | 200 |
| 12. | Redwood Cañon Forest | Redwood and Eshom crs., Tulare Co. | 3000 | 5500–7000 | 15,000 |
| 13. | North Kaweah Forest[2] | North Fork Kaweah R., Tulare Co. | 500 | 6000–7000 | 1000 |
| 14. | Giant Forest[3] | Marble Fork Kaweah R., Tulare Co. | 9000 | 6000–8000 | 20,000 |
| 15. | Cliff Creek Grove[4] | Middle Fork Kaweah R., Tulare Co. | 15 | 7000 | 100 |
| 16. | Harmon Meadow Grove | Middle Fork Kaweah R., Tulare Co. | 13 | 7000 | 100 |
| 17. | Mineral King Forest[5] | East Fork Kaweah R., Tulare Co. | 1500 | 6000–7500 | 3000 |
| 18. | Lake Cañon Grove | East Fork Kaweah R., Tulare Co. | 20 | 5000–6000 | 80 |
| 19. | Mule Gulch Grove | East Fork Kaweah R., Tulare Co. | 25 | 5000–6000 | 70 |
| 20. | Homer Peak Forest[6] | East Fork Kaweah R., Tulare Co. | 5500 | 5500–7000 | 3000 |
| 21. | South Kaweah Forest | South Fork Kaweah R., Tulare Co. | 3000 | 5000–7000 | 6000 |
| 22. | Dillon Forest | North Fork Tule R., Tulare Co. | 1000 | 5000–7000 | 1200 |
| 23. | Tule River Forest | Middle Fork Tule R., Tulare Co. | 3500 | 5500–7000 | 5000 |
| 24. | Pixley Grove | Middle Fork Tule R., Tulare Co. | 850 | 6500–7000 | 500 |
| 25. | Fleitz Forest | Middle Fork Tule R., Tulare Co. | 1900 | 5000–6500 | 1500 |
| 26. | Putnam Mill Forest | Middle Fork Tule R., Tulare Co. | 4000 | 5500–6000 | 3500 |
| 27. | Kessing Groves | South Fork Tule R., Tulare Co. | 2800 | 5500–7000 | 2400 |
| 28. | Indian Reservation For. | South Fork Tule R., Tulare Co. | 1500 | 6000 | 1200 |
| 29. | Deer Creek Grove | South Fork Deer Creek, Tulare Co. | 300 | 7000 | 150 |
| 30. | Freeman Valley Forest | Kern River, Tulare Co. | 1000 | 5500–6500 | 500 |
| 31. | Kern River Groves | Kern River, Tulare Co. | 700 | 6500–7000 | 350 |

[1] This grove may be separated into two bodies; (*a*) West Boulder, 3000 acres, 6000 to 8000 feet altitude, 6000 trees; (*b*) East Boulder, 200 acres, 7000 to 8000 feet, 450 trees. Ten Mile Grove, east headwaters of Ten Mile Creek, is part of the Boulder Forest as here taken. It covers 50 acres at 7000 ft. altitude with 100 trees. Indian Basin Grove is on Indian Creek, a west fork of Ten Mile; it has 160 trees scattered over 80 acres at 6000 ft. altitude.

[2] Also called Black Oak Forest.

[3] The Swanee River Grove, on the Swanee Fork of the Marble Fork, contains 129 trees, covering about 20 acres, altitude 6500 feet. It is considered by Walter Fry, Acting Superintendent of the Sequoia Park, as a distinct grove, but has been included in the Giant Forest in the writer's list and on the map.

[4] Between Cliff Creek and Middle Fork; commonly called Redwood Meadow Grove.

[5] Also called Atwell Forest.

[6] Also called Salt Creek Forest.

The question of reproduction has especial interest. The opinion that the Big Tree is not reproducing has long been current in the popular literature. This statement is in large part true as to the northern groves, where in most places the humus cover appears to be too dry to favor the germination of seeds. Cones are produced in great abundance and contain about three hundred and thirty seeds. Although many of the seeds are infertile the proportion is not serious; a sufficient number contain good embryos and will grow under the quickening influence of a moist soil. Reproduction is most abundant in the southerly groves and numberless seedlings and young trees of every age may be seen in the Sequoia Park. Seedlings are most abundant in small "burns" or fire-spots, which are still protected by the mother forest. Young trees are numerous about Atwell's Mill on the Mineral King Road and exhibit a weed-like rankness, but if the entire forest were cut away clean it is unlikely that seedlings would withstand the direct heat of the summer sun and the erosion of surface soil by winter rains.

The life-history of the tree in the forest can, therefore, best be studied in the southern Sierra. Thriving trees twenty to a hundred years old have narrowly pyramidal bases tapering to slender, pointed tops and at once recall the familiar outline of arbor-vitae in garden collections. During this period the bark resembles the bark of the cypress. Between eighty and one hundred years the first heart-wood appears and the corky bark is replaced on the main trunk by the deep red fibrous bark, which becomes one to two feet thick and is fissured into longitudinal or sometimes spiral ridges. From youth to the adult stage the trunk is very tapering with the branches above erect, at the middle horizontal and below sweeping downward to the ground. As the tree matures the shaft loses branches from below and in its prime is beautifully characterized by its rounded crown. A notable feature is that the branches, relatively to the size of the tree and of the trunk, are very short. As the tree passes its prime it continues to lose branches, the top becomes thinner, the limbs very stout and stumpy and densely massed with foliage, the tip of the shaft is killed by storm or lightning, and the crown which by its rounded outline characterized the period of middle age, is now ragged and broken. (Plate 50, fig. 2.)

Notwithstanding that the Big Tree is naturally limited to the Sierra Nevada it is planted successfully on the plains of the San Joaquin, where there are well-grown trees, forty or fifty feet high, which do not seem to be affected by extreme summer temperatures of 95 to 110 degrees. It is also cultivated on the Californian coast, in the eastern United States and in the countries of western and southern Europe. About eight horticultural varieties are distinguished in cultivation.

The wood of the Big Tree is light and very straight grained, but is more brittle than the Redwood, not so strong and does not work as readily. Its sapwood

is white, three to five inches thick, and the heart-wood is red, generally but not always redder than in *Sequoia sempervirens*. Freshly sawed lumber is of a bright pink color, which is strikingly unlike the deeper red color of the Coast Redwood. Big Tree wood has extraordinary durability, fallen logs in the forest having remained sound for several centuries. It is used for posts, farm-buildings, shingles, raisin-trays and for stakes in vineyards. It seems unfortunate that timber of such magnificent proportions cannot be applied to larger uses than grape-vine stakes.

Measurements of the Big Tree on record in the popular literature are usually circumference measurements of the trunk taken at the ground. One of the most wonderful and impressive things about *Sequoia gigantea* is the manner in which the trunk from a point a few feet above the ground sustains its girth upward, the taper often being very slight to the eye or even inappreciable. The trunk is, however, always swollen at base and sometimes its bulge is tremendous, so that the diameter taken at the ground, while of great interest, gives no just idea of the actual size.[30] In the summer of 1900, while on an expedition through the southern Sierras, one hundred and sixty-four trees within one hundred yards of Round Meadow in the Giant Forest were measured. Some of the trees in which the bulge at base was very strong are given in the following table. These trees were one hundred and fifty to two hundred feet high. The upper measurement was taken at a point which seemed best calculated to give a true value to the trunk.

| No. | Circumference at ground | Circumference at height indicated | No. | Circumference at ground | Circumference at height indicated |
|---|---|---|---|---|---|
| 7 | 62 feet | 39½ feet at 10½ feet. | 71 | 67 feet | 45 1/12 feet at 10 ft. |
| 17 | 25 feet | 15½ feet at 12 feet. | 102 | 30 feet | 15¾ feet at 11 feet |
| 30 | 13⅔ feet | 8½ feet at 7 feet. | 133 | 72 feet | 57 5-12 ft. at 11 ft. |
| 31 | 51 7-12 feet | 30 5-12 at 12 feet. | 163 | 27½ feet | 17½ feet at 9 feet. |

The best table of Big Tree measurements is that made by George B. Sudworth for trees in the Calaveras Grove. He measured thirty trees which ranged from nine feet to nineteen feet and six inches in diameter at six feet above the ground and were two hundred and thirty-seven to three hundred and twenty-five feet in height. There are no authentic measurements of living trees of greater height, or at least none accessible. The perfect symmetry of the trunk deceives the eye sadly as to actual height, but long association with these monarchs and ancients of the forests give one in time a juster appreciation of their stature—a limb breaking off in the top of a tree with a rifle-like report assists in correcting the eye's error by the amount of time consumed in its downward flight.

The Big Trees, by reason of their thick bark, are wonderfully resistant to

[30] Plate 50, fig. 1.

fire. They have, however, been subject to devastation for many centuries past and repeated fires have gradually eaten into the hearts of many trunks. Nearly all trees are at least fire-scarred, and greater damage is so frequent that one comes instinctively to look for a hollow on the side of a trunk. A trunk which may appear perfect may be found hollowed when one has completed a little journey about it.

The lumbering of the Big Tree quite outclasses that of all other trees in wastefulness. On account of its great height the tree smashes badly in its fall unless the lay of the land permits the exercise of nice judgment. The logs sawed from the trunk are, however, often too large to be moved by the usual methods of logging and resort is had to gunpowder or dynamite to split them up, another item of great waste. Sometimes logs are quartered for the mill by specially constructed bandsaws. Add to the above the usual loss in the mill in sawing and but 50 per cent. of the tree comes out as lumber. It is for these reasons, as well as on account of the inacessibility of the groves, that the business is not highly profitable and is sometimes conducted at a loss.[31]

The question of the age of the Big Tree has for a long time afforded a field for free speculation on the part of popular writers, who have offered some amazingly large figures for public consumption. All fanciful guesses can now, however, be set aside. The logging of the Converse Basin and other forests has given ample opportunity for age studies, and counts of rings demonstrate that the average age of adult trees is 400 to 1500 years. A few trees show as high as 2200 or 2300 rings. It may be stated that John Muir has discovered one exceedingly large individual which, after careful study of portions of the burned cavity at base of the trunk, he believes to be 4000 years of age.

[31] The rapid increase in value of timber lands and lumber has radically changed these conditions within the last five years. Greater care and economy with reference to the tree in the forest and to the log in the mill is, moreover, being exercised with the rise of timber values.

## CUPRESSACEAE. Cypress Family.

Trees or shrubs with opposite or whorled scale-like (or rarely linear) leaves thickly clothing the ultimate branchlets. Stamens and ovules in separate catkins. Staminate catkins terminal on the branchlets, small, with shield-like stamens bearing 2 to 6 pollen-sacs. Ovulate catkins consisting of several opposite or whorled scales which bear at base 1 to several erect ovules. The "scales" in the family consist morphologically of a completely blended scale and bract.—Nine genera, widely distributed over the earth. Thujopsis (Japanese Arbor-vitae) is in cultivation with us.

### Key to the Genera.

Fruit a woody cone; stamens and ovules on same tree.

Branchlets flattened, disposed in flat sprays; leaves opposite, in 4 rows, the successive pairs unlike; cones maturing in first autumn; seeds 2 to each scale.

Scales of cones imbricated.

Cones pendent, scales 4 to 7, only the middle pair seed-bearing; seeds unequally 2-winged ..... 1. Libocedrus.

Cones reflexed, scales 8 to 12, the 2 or 3 middle pair seed-bearing; seeds equally winged ..... 2. Thuja.

Scales of cones peltate; seeds narrowly winged ..... 3. Chamaecyparis.

Branchlets cord-like, not in flat sprays; leaves opposite, in 4 rows, alike; cones maturing in second autumn; seeds acutely margined, many to each scale ..... 4. Cupressus.

Fruit a berry; seeds 1 to 3 to each fruit; stamens and ovules on different trees; branchlets cord-like; leaves in whorls of 3 or opposite ..... 5. Juniperus.

### 1. Libocedrus Endl. Incense Cedar.

Aromatic trees with flattened branchlets disposed in one plane. Leaves scale-like, opposite, imbricated in 4 rows, the successive pairs unlike. Staminate and ovulate catkins terminal on separate branchlets. Staminate catkins with 12 to 16 decussately opposite stamens, each bearing 4 to 6 pollen-sacs. Ovulate catkins consisting of 4 to 8 scales, only one pair ovule-bearing, each scale of this pair with 2 ovules at base. Cone maturing in one season, oblong, composed of 6 imbricated oblong scales. Seeds unequally 2-winged; cotyledons 2.—Eight species, one on the Pacific Coast of North America, two in Chile and five in the region from southwestern China to New Zealand.

### 1. **Libocedrus decurrens** Torr.

INCENSE CEDAR.

Plate 51, figs. 3-5.

LIBOCEDRUS DECURRENS Torrey, Pl. Frem., p. 7, pl. 3 (1853); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 63 (1857); Engelmann, Bot. Cal., vol. 2, p. 116 (1880); Kellogg, For. Trees Cal., p. 17 (1882); Lemmon, 3rd Rep. Cal. Board For,. p. 173, tt. 22, 23 (1890); Coville, Bot. Death Val. Exped., p. 224 (1893); Veitch, Man. Conif., p. 253 (1900); Lawson, Ann. Bot., vol. 21, p. 281 (1907); Sargent, Silva N. Am., vol. 10, p. 135, t. 534 (1896).

*Thuja Craigana* Murray, Rep. Oreg. Exped., p. 2, t. 5 (1854).

Forest tree 50 to 150 feet high with the strongly conical trunk very thick at base (1 to 6 feet in diameter) and gradually diminishing in size upwards; bark thick, red-brown, loose and fibrous, in age broken into prominent heavy longitudinal furrows; ultimate branchlets alternate, numerous, forming flattish sprays and clothed with adherent leaves as if jointed; leaves 1 to 4 lines long, in four ranks and in opposite pairs, coherent and adherent to the stem, free only at tip, those above and below obtuse but minutely pointed and forming a pair overlapped by the keel-shaped lateral pair; staminate catkins 1½ to 2 lines long, the pollen-sacs usually 5 to each scale which ends in a broad roundish crest; ovulate catkins borne singly at the ends of branchlets; cones red-brown, oblong-ovate when closed, ¾ to 1 inch long, consisting of 2 seed-bearing (or fertile) scales with 1 (morphologically 4) sterile scale between them and often with 2 supplementary ones at base; seed-bearing scales broad and flattish but not thin; all the scales with a small triangular umbo at tip; seeds 4 lines long, margined on each side from near the base to the apex by two very unequal wings; larger wing elliptical in outline, 5 to 9 lines long.

The Incense Cedar inhabits open mountain sides, cañons, and plateaus and is distributed from the Cascade Range of Oregon southward through California to Mt. San Pedro Martir in Lower California. In the Sierra Nevada it is, in company with the Yellow Pine, White Fir and Sugar Pine, one of the four most important trees in the main forest belt and it is here that it attains its greatest size. In Southern California it is found on the Cuyamaca Mountains, San Jacinto, San Bernardino and Sierra Madre ranges. In the Coast Range it is comparatively uncommon and very restricted in its distribution, occurring in the high mountains of Siskiyou, Humboldt and Trinity counties and thence along the Yollo Bolly Range to the Mayacamas Range as far as Mt. St. Helena, that is, only in those high ranges which are inhabited by the Sugar Pine. I have never seen it in the seaward North Coast Ranges, nor yet in the Mt. Diablo and Mt. Hamilton ranges, but it occurs in the Santa Lucia Mountains of Monterey County. It was at one time common on San Benito Peak of the San Carlos Range at about 4000 feet, but has been almost completely cut away for timbering

in the New Idria Mine. A few scattered seed trees are responsible for the seedling growth which is of an encouraging character. Some of the former growth consisted of good-sized trees, one stump, measured in 1907, scaling five feet in diameter at three feet above the ground.

Incense Cedar does not stump-sprout, but it seeds freely and reproduces itself abundantly and persistently. On lumbered and fire-destroyed areas in the Sierra it makes a better stand under diverse conditions of slope and moisture than any of the associated species except the Yellow Pine, which it equals in aggressiveness in the earlier stages of its life history. The seedlings are of special interest in that they display three types of leaves: the two cotyledons are 1 to 1⅛ inches long, 1 line wide, and are larger than any leaves which follow; the primary axis of the seedling bears linear leaves ½ inch long; while the first branches bear awl-shaped transitional leaves which grade into the normal foliage. In the second and third year the branches are chiefly or wholly in one plane.

Incense Cedar was first observed by Fremont on the south fork of the American River while on the Second Expedition in 1844 (Rep. 139). The specimens used by Torrey in describing the species were obtained on the headwaters of the Sacramento River, during the Third Expedition in 1846. In the coloration and tapering character of its trunks it strongly resembles the Big Tree, while its general outline is often similar to that species.

The wood is light, soft, close-grained, reddish brown and aromatic. It shows exceeding durability in contact with soil and is, therefore, the favored timber for fence posts and rails in the Sierra settlements. While more largely used for this purpose than any other, it is also split into shakes and sawn into lumber for flumes, interior finishing, and telegraph and telephone poles. By woodsmen it is variously called Red Cedar, White Cedar, Bastard Cedar, and Post Cedar. A considerable proportion of the logs are injured by dry rot, which does not, however, affect the durable qualities of the wood.

### 2. Thuja L. Arbor-vitae.

Aromatic trees with scattered branches, the flattened branchlets disposed in one plane. Leaves scale-like, opposite, and imbricate in 4 rows, the successive pairs unlike, adnate with free tips. Catkins terminal. Staminate catkins with 4 to 6 stamens, each with 3 or 4 anther-cells under the subpeltate crests. Ovulate catkins with 8 to 12 erect scales, each with 2 erect ovules at base. Cones small, maturing the first autumn, reflexed; scales 8 to 12, thin-leathery, the lowest and uppermost pairs sterile. Seed bordered by nearly equal lateral wings so as to be nearly elliptic; cotyledons 2.—Four species, two in North America, and two in China and Japan.

## 1. **Thuja plicata** Don.

### Canoe Cedar.

Plate 51, figs. 1-2.

Thuja plicata Don in Lambert, Pinus, vol. 2, p. 19 (1828); Sudworth, Rep. U. S. Sec. Agr., 1892, p. 328.

*Thuja gigantea* Nuttall, Jour. Phil. Acad., vol. 7, pt. 1, p. 52 (1834), Sylva, vol. 2, p. 162 (1865); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 56, fig. 22 (1857); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 25, 69 (1860); Lyall, Jour. Linn. Soc., vol. 7, pp. 133, 144 (1864); R. Brown Campst., Trans. Bot. Soc. Edin., vol. 9, pp. 338, 367; Engelmann, in Bot. Cal. vol. 2, p. 115 (1880); Lemmon, 3rd Rep. Cal. Board For., p. 171, tt. 20, 21 (1890); Veitch, Man. Conif., p. 239, fig. (1900); Sargent, Silva N. Am., vol. 10, p. 129, t. 533 (1896).

Giant trees of pyramidal outline, slender branchlets and drooping sprays, with trunk vested in cinnamon-red bark; branchlets repeatedly 2-ranked, forming flat sprays, thickly clothed with minute leaves which are closely imbricated in 4 ranks and conceal the stem; leaves in opposite pairs and of 2 kinds, those on the margin of the flat sprays keeled or somewhat boat-shaped and acute at tip, those above and below flattish and triangular at apex; cones borne on short lateral branchlets, on opening turned downward beneath the spray, cinnamon-color, oblong in outline when closed, and 6 to 7 lines long; scales 9, the outer ones oblong or obovate, and much broader than the narrow inner ones; seed winged all around and with a narrow notch at apex, the whole structure 3 lines long.

The Canoe Cedar, also called Giant Arbor-vitae, Oregon Cedar, or Red Cedar, is distributed from the Bear River Range near Cape Mendocino northward to southeastern Alaska and eastward to the westward slope of the Rocky Mountains in the Columbia River region. It occurs only sparingly in the Redwood Belt of northwestern California, is mostly but fifty to eighty feet high and one to three feet in trunk diameter. On the coasts of Oregon and Washington it reaches its greatest development and is a timber tree of great abundance. In the moist coastal region it becomes one hundred and fifty to two hundred and twenty-five feet high with trunks eight to sixteen feet in diameter near the base, and furnishes the most important resource for the shingle industry on the Pacific Coast. The heart-wood is reddish brown, light, brittle, easily worked and very durable. It is chiefly employed for shingles which neither warp nor split, but is also used for farm buildings, posts and barrels. On account of its being so slightly affected by sun and rain it is, furthermore, a favorite lumber for the manufacture of doors and window-casings. From a single log, the Indians of the Northwest Coast fashioned canoes twenty to forty feet long, remarkable for their beautiful lines and for their lightness; the extended prows were often carved into curious figures or symbols. The fibrous inner bark is

cut into ribbon-like strips and used by the native tribes for a great variety of purposes, such as weaving into mats, cloth, bags and baskets.

*Thuja plicata* was first collected by the Malaspina Expedition at Nookta Sound on the Northwest Coast in 1791, and a few years later by Menzies. Douglas later collected it near the Columbia River on the coast, as did Nuttall.

### 3. Chamaecyparis Spach.

Trees or shrubs; leading shoot nodding; branchlets more or less flattened and in flat sprays; leaves opposite, in 4 rows, the successive pairs in ours unlike. Catkins and cones very similar to Cupressus. Stamens with usually 2 pollen-sacs. Ovules 2 to 5 at the base of each scale, the seeds winged, usually 2 (1 to 5). Cones maturing in the first season. Cotyledons 2.—Six species, 3 in North America and 3 in Japan. C. nootkatensis Lamb., Nootka Cedar or Yellow Cypress; bark thin, irregularly fissured into flat ridges; branchlets not flattened; leaves alike, usually not glandular; northern Oregon to Alaska.

### 1. **Chamaecyparis Lawsoniana** Parl.

Port Orford Cedar.

Chamaecyparis Lawsoniana Parlatore, in DeCandolle's Prodromus, vol. 16, pt. 2, p. 464 (1868); Engelmann, in Bot. Cal., vol. 2, p. 114 (1880); Kellogg, For. Trees Cal., p. 15 (1882); Lemmon, 3d Rep. Cal. Board For., p. 177, t. 24 (1890).

*Cupressus Lawsoniana* Murray, Edin. New. Phil. Jour., n. ser., vol. 1, p. 292, pl. 10 (1855); J. D. Hooker, Bot. Mag., t. 5581 (1866); Sargent, Silva N. Am., vol. 10, p. 119, t. 531 (1896); Veitch, Man. Conif., p. 205 (1900).

*Cupressus fragrans* Kellogg, Proc. Cal. Acad., vol. 1, p. 103 (1857).

Forest tree 80 to 175 feet high, with straight shafts and narrow crown of drooping branches ending in broad flat drooping fern-like sprays; bark brown or somewhat reddish, smooth on young trees, later parting on the surface into large loose, thin shreds and finally in adult trees fissured longitudinally with the furrows continuous and separated by flat ridges; leaves adpressed, scale-like, thickly clothing the branchlets, disposed in opposite pairs, those above and below rhomboidal, glandular-pitted, and overlapped by the keel-shaped ones on the margin; staminate catkins crimson; ovulate catkins consisting of about 7 scales, maturing in the first autumn into globose cones 3 to 4 lines long; seeds 1½ to 2 lines long, narrowly wing-margined on each edge, the whole structure orbicular.

The Port Orford Cedar grows on moist hillsides or cañon bottoms and is distributed from Coos Bay in southwestern Oregon to northern Humboldt in California and thence eastward to the Sacramento River cañon. Although this

is one of the most important timber trees of western America the entire acreage is, economically considered, practically restricted to the Coos Bay district, and is therefore comparatively limited. It is, however, the most abundant tree in the forest between the Coquile River and Port Gregory, where it likewise attains its greatest development. The tallest of all the Cypresses, it reaches here an average height of one hundred and twenty-five to one hundred and fifty feet, an extreme height of nearly two hundred feet, with trunks clear of branches for two-thirds their height and four to twelve feet in diameter near the ground. The trees in California are in scattered localities and few in a place. In the deep gorge of Quartz Creek in Del Norte County there are slender trees 150 feet high; there is also a grove on Shelly Creek. On the Kelsey Trail across the Klamath Range there are trees eighty to one hundred feet high and two to four feet trunk diameter at Willis Hole, Cedar Camp and elsewhere in the vicinity, in some places associated with *Picea Breweriana.* In a cañon bottom on the Hupa Wagon Trail above Three Creeks, tributary of the Trinity, there are individuals one hundred to one hundred and twenty-five feet high with trunks three feet in diameter. Localities have been reported on Mad River, on Halls Gulch of east fork Trinity, and around Trinity Center. In the Sacramento River Cañon, where it was discovered by William Murray in 1854, it occurs from Slate Creek to Shasta Springs.

In gardens the Port Orford Cedar is most commonly called Lawson Cypress and is highly admired for its habit and hue of foliage. Under cultivation the lowest branches usually persist and spread widely so that the pyramid rests directly on the ground. Introduced into cultivation shortly after its discovery in 1854 it is now extensively grown throughout America and northern Europe. No other West-American tree has taken more kindly to horticultural methods or has varied so much under cultivation. No less than sixty-eight garden forms have received distinct varietal names. These fall roughly into two main groups, one distinguished by habit, the other by color of foliage.

The wood is straight and very close-grained, soft, elastic, durable, white or cream-tinted, takes a fine smooth polish and is used for flooring, doors, and interior finish, although avoided for most cabinet work by reason of its volatile resin. By lumbermen it is sometimes termed "Ginger Pine" on account of the spicy fragrance and some woodsmen use the names "Oregon Cedar" and "White Cedar."

The specific name, *Lawsoniana,* is in honor of Charles Lawson (1794-1873), Scottish nurseryman, writer on trees and grasses, author of a sumptuous work called the Pinetum, and one time Lord Provost of Edinburgh.

### 3. Cupressus L. Cypress.

Trees or shrubs with the leaves small and appressed, scale-shaped and closely imbricated in four ranks on the ultimate branchlets, or awl-shaped on vigorous shoots. Staminate catkins terminal on the branchlets, with 3 to 5 pollen-sacs to each stamen. Ovulate catkins upon short lateral branchlets, the ovules numerous, erect, in several rows at the base of the scales. Cones globose to oblong, maturing in the second year, the shield-shaped scales fitting closely together by their margins, not overlapping, separating at maturity, their broad summits with a central boss or short point. Seeds acutely angled or margined; cotyledons 2 to 5.—North Temperate Zone, about fourteen species, six in North America.

Key to the Species.

Umbos low, crescent-shaped, upwardly impressed.
  Glands on leaves none or rare; maritime species.
    Seed small, black ..... 1. *C. Goveniana.*
    Seed larger, brown ..... 2. *C. macrocarpa.*
  Glands on leaves present as dorsal pits; seeds brown ..... 3. *C. Sargentii.*
Umbos conical, well-developed, spreading; leaves with conspicuous resin-bearing pits.
  Cones red-brown, 5 to 8 lines long; umbos typically incurved ..... 4. *C. Macnabiana.*
  Cones silvery or glaucous, 4 to 6 lines long; umbos short conical ..... 5. *C. Bakeri.*

### 1. **Cupressus Goveniana** Gordon.

Gowen Cypress.

Plate 52, figs. 2, 3.

Cupressus Goveniana Gordon, Jour. Hort. Soc. Lond., vol. 4, p. 295 (1849).

Var. pygmaea Lemmon, Handb. West Am. Conif., p. 77 (1895).

*C. pygmaea* Sargent, Bot. Gaz., vol. 31, p. 239 (1901).

*C. Goveniana* var. *parva* Lemmon, Sierra Club Bull., vol. 4, p. 116 (1902).

Small shrub 1 to 15 feet high, the trunk bark brown, smoothish; leaves commonly without pits, rarely with lateral depressions; cones light brown, subglobose or oval, 6 to 8 lines long, rarely larger, with 3 or 4 pairs of scales; umbo short, thin-edged, upwardly impressed; seeds black or dark brown, sometimes drab, angular or acutely margined, minutely warty, 1 to 1½ lines long.

The Gowen Cypress grows at Monterey on "pine-barren" country about two miles west of old Monterey town in company with the Bishop Pine on the west slope of the Point Pinos Ridge. There is said to be another locality

about one mile southeast of the Point Lobos Ranch, south of the Carmel River, and about sixty rods from the ocean.

The var. *pygmaea* or Dwarf Cypress is abundant on the Mendocino pine barrens or so-called "White Plains," a low alkaline plateau lying one to five miles back of the shore, where it is represented by four habital forms. The most remarkable of these are the dwarfs barely one or two feet high, with unbranched axis and only a few short branchlets. Associated with them, but occupying spots less strongly charged with alkaline salts, is the shrub form, a bushy type, freely branching and six to fifteen feet high. Only a few yards away from the dwarfs where the soil and moisture change somewhat, slender poles fifteen to twenty-five feet high grow in a crowded situation. The fourth type is strictly arboreous. Back of Fort Bragg two miles I found in a miniature swale of the plain two trees seventy-five feet high, the clean trunks thirty and forty feet high and two feet ten inches and two feet eight inches in diameter respectively at four feet above the ground. The Mendocino dwarf cypress has been named *C. pygmaea* by Sargent, but this shrub is here taken to be conspecific with the original *C. Goveniana* collected by Hartweg in 1846 at Monterey, since the latter has similar cones and black seed.[32]

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[32] The original specimens of *Cupressus Goveniana* Gord. were collected on the Monterey Peninsula by Theodore Hartweg in 1848, who writes in his journal as follows: "When the weather permitted it I continued my rambles on foot in the mountains of Monterey, and discovered on the western declivity, within two miles of the seashore, a species of Pine (*Pinus muricata* Don) which I had not found previously. . . . In the same locality with the above Pine, I observed a Cypress (*Cupressus*, No. 166) with smaller cones than *C. macrocarpa*, of which it seems more than a variety, being a stunted shrub six to ten feet high." (Jour. Lond. Hort. Soc., vol. 3, p. 217.) No. 166 was distributed as 1971 (Bentham, Pl. Hartw., p. 337).

Near the center of the Pacific Improvement Company's reservation is a small grove of *Cupressus Goveniana* some two hundred yards long and averaging a few yards wide. It is undoubtedly the original station both as determined by geographical evidence and by comparison of material with the type in the Kew Herbarium. The shrubs in this grove are 4 to 10 or rarely 15 feet high, and stand very thickly, mostly three to six to the square foot. They are all one thing. The taller shrubs branch freely with the cones in usually very heavy clusters towards the ends of the branches. Younger shrubs are mostly cane-like and without any main branches; they bear cones freely and early, even producing a cone or two when only one foot high. On his visit to this grove in January, 1910, the writer found the fruit to be very variable, in size of cones and development of scales, the latter being smooth or producing small or even horn-like umbos. While the seeds are commonly black, they are sometimes light or dark brown. They are, rightly, always some shade of drab, either light or dark, the term "black" being a slight exaggeration in order to emphasize and render intelligible the color differences which do exist in our cypress species.

Some years previously the author had decided to refer *Cupressus pygmaea* Sarg. to *Cupressus Goveniana* Gord., being impelled thereto by the following considerations: Both have squarish ultimate branchlets; both have leaves with few or no resin-pits; both have small or medium sized cones with generally inconspicuous umbos; and both have dark brown or black seeds which are warty or papillate, and essentially of a size. Both, yet again, grow in practically identical habitats near the sea and produce individuals which fruit very young and when only one or two feet high, but these latter facts, while interesting, are of no taxonomic importance.

On the other hand it must be said that cone characters are of little or no practical value in the separation of our species on account of the variability in size of the cones and development of the umbos. Resin pits would seem to be more strongly developed on shrubs of interior stations, while papillate seeds are not entirely restricted to the above named forms. It is not impossible that habital features, in lieu of the weakness of technical characters, may prove a weighty factor in the segregation of our Cypress forms and in view of this the Mendocino cypress may be retained as a variety, chiefly out of consideration for its habit of branching, which is more nearly like that of *Cupressus macrocarpa*. It has, however, no technical point of difference from the Monterey type of *Cupressus Goveniana*.

## 2. **Cupressus macrocarpa** Hartweg.

MONTEREY CYPRESS.

Plate 52, fig. 1; pl. 11.

CUPRESSUS MACROCARPA Hartweg, Jour. Hort. Soc. Lond., vol. 4, p. 296, fig. (1849), vol. 2, p. 187 (1847); Torrey, Bot. Mex. Bound., p. 211 (1859); Watson, Bot. Cal., vol. 2, p. 113 (1880); Hooker, Gard. Chron., 1885, p. 176, fig.; Lemmon, 3rd Rep. Cal. Board For., p. 180, tt. 25, 26 (1890); Sargent, Gard. & For., vol. 7, p. 241, fig. 41 (1894), Silva N. Am., vol. 10, p. 103, t. 525 (1896); Veitch, Man. Conif., p. 215 (1900); Matthews, Tree-cult. New Zealand, p. 106 (1905).

Littoral tree 15 to 80 feet high with trunk 1 to 3 feet in diameter, the branches spreading and forming a regular conical crown or exceedingly distorted and irregular; ultimate branchlets numerous, fine and subterete, densely clothed with triangular scale-like leaves; leaves ½ to 1½ lines long; staminate catkins ovate or subglobose, 1 to 2 lines long, borne at the ends of the ultimate branchlets; ovulate catkins greenish, composed of about 5 pairs of broadly ovate thinnish scales; cones dull brown, broadly oblong or subglobose, 1 to 1¾ inches long; scales flat-topped, with a central curved thin-edged ridge-like umbo; seeds 1 to 2 lines long, narrowly wing-margined but irregularly shaped from crowding in the cones and with a minute white lanceolate attachment scar at base.

The Monterey Cypress inhabits the ocean shore and forms two groves, one at Cypress Point near Monterey and the second at Point Lobos. It is most restricted in its distribution of any Californian tree and of any coniferous species in the world. The wind-broken and most admired individuals stand in exposed places on the bluffs or cling to the very face of the rocky cliffs within reach of the flying ocean spray. In such situations they are carved into picturesque and oft-times singular shapes remarkable for the density of the masses of foliage presented towards the ocean and the flattened or board-like character of the supporting trunks. Many of these trees simulate the classical figures of the Cedars of Lebanon and it is not uncommon for the drivers on the "Seventeen-mile Stages" to cater to a taste for the romantic and speak of them as such. A little back from the shore, where the trees protect each other, they assume regular forms, as regular as those of trees in cultivated plantations. Most of these protected trees have very open crowns and finger-pointed main branches.

The Cypress Point Grove extends along shore from Pebble Beach near Pescadero Point north to Cypress Point, being about two miles long and extending inland about sixty rods. It contains many thousand trees, growing both on the exposed shore line and back of the shore line, forming dense colonies on slopes or in swales. (Fig. 1, page 15, and plate 11, fig. 1.)

The assemblage of Cypress at Point Lobos (Carmel) is very much smaller but is a fine one and very interesting. This point consists of two rocky headlands into each of which the ocean is cutting narrow firths. The trees are in two bodies, crowning each headland, and also extending out onto the narrow tongues of land between the firths. (Plate 11, fig. 2.)

The effect of the wind upon the trees growing in exposed situations is by reason of their moist habitat due less to effect of excessive transpiration than to mechanical strain. One may see two trees standing side by side, of equal height and equally exposed, one a young tree with slender, pointed, symmetrically pyramidal crown, the other an old tree, its trunk shorn of branches and rising to a battered but thick flat-topped crown.

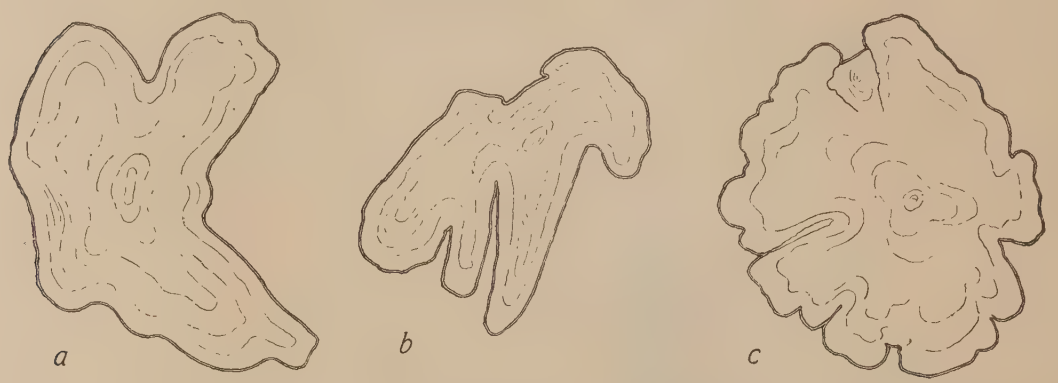


Fig. 11. *Cupressus macrocarpa* Hartw. (Monterey Cypress), section of trunks, showing buttressing. *a*, ideal section of tree 70 feet high near Pescadero Point, Monterey County, circumference of trunk (on stretched tape), 21 feet, 3 inches at 4 feet above the ground; *b*, ideal section of tree in same locality, circumference of trunk (on stretched tape), 15 feet at 4 feet above ground; *c*, actual section of tree grown on University of California grounds, diameters, 22 and 26 inches.

Unsymmetrical trees, whose configuration is due in the main to wind, fall roughly into three types:

1. Trees with long, much thickened lower branches and irregular crowns. 2. Trunks mainly dismantled of branches, ending above in a flat hat-like crown of compactly woven branchlets. 3. Trees crouching together in small companies and building up to leeward an even dense wall of foliage.

As a result of wind-strain on top, or load of one-sided crown, trunks often become heavily buttressed or swollen unsymmetrically at base. Excessively buttressed trees usually stand in the most exposed places. Sections of buttressed trunks are shown in figure 11. On the other hand, trees standing equally near the shore line exhibit trunks not buttressed, or inappreciably. Buttressing is also more or less correlated with root development.

In cultivation the Monterey Cypress has long been a favorite shelter and hedge plant in California and is easily propagated by seed which is readily germinated within two or three weeks in open-air nursery beds. Each cone produces about one hundred and fifty seeds. The seedlings grow with weed-like rapidity. Practically all Cypress hedges in California are of this species. It lends itself to the art of the formal gardener by whom it is almost always clipped into regular forms or even into most fantastic figures. It is a successful windbreak and is much used for that purpose since it will grow an erect body in places where the wind promptly controls other species. As an ornamental tree it has also been widely planted, but has comparatively little to recommend it save its rapid growth and dense crown.

The present exceedingly limited area of its natural home must have been caused by change in climatic conditions, since the tree itself is vigorous and readily adapts itself to cultivation in many parts of the world. Its seeds are light and easily dispersed; they germinate promptly under favorable conditions; the seedlings grow rapidly and show vigor. Nevertheless this species could never extend itself over the dry Coast Range hills unaided. Even trees planted in the Sacramento Valley thirty and forty years ago have died off during the last fifteen years with great regularity. Grown in the interior their constitutional vigor seems weakened by the dryness of the hot valleys and they succumb to the attacks of borers.

The age of Monterey Cypress in the native groves is not readily determinable, since the trees, on account of their rarity and interest, are not cut either for fuel or lumber. One fallen tree sawn through to remove it from a roadway was ninety-eight years old and had a trunk two feet in diameter. Since the tree grows rapidly it would seem fair to hazard that two hundred to three hundred years represents the extreme age of the older trees. The advertisement of them in seaside literature as one thousand to two thousand years old does not, so far as the writer is able to determine, rest upon any actual data, and probably represents a desire to minister to a popular craving for bigness and extremes.

Hartweg found *Cupressus macrocarpa* near Carmel in 1846 and on his specimens the species was founded. Seed, however, was collected at an earlier date and sent to England, the seedling trees being called *Cupressus Lambertiana*. For over one-half century it has been planted in England and various parts of Europe, and has also been carried to Australia and southern South America. In New Zealand it is widely planted as a shelter plant, but, as in California, it is short-lived except on deep soil near the coast.

In horticulture a number of color, leaf and branch forms have been developed; in one (var. *lutea*) the tips of the branches are light yellow or golden, changing to green in the second year; in another (var. *Crippsii*) the leaves are

spreading instead of appressed with the tips of the youngest growth light yellow; in a third (var. *Lambertiana*) the habit is spreading. The var. *farallonensis* Masters is perhaps a cultural form whose origin is unknown. It certainly could not have been derived from the barren, rocky Farallone Islands as stated by Dr. Masters.

The wood is heavy, hard, strong, and close-grained, the basal parts of the trunks in particular furnishing highly ornamental patterns.

### 3. **Cupressus Sargentii** Jepson.

SARGENT CYPRESS.

Plate 52, fig. 6.

CUPRESSUS SARGENTII Jepson, Fl. Cal., pt. 1, p. 61 (1909).

*Cupressus Goveniana* Engelmann in Bot. Cal., vol. 2, p. 114 (1880), in part; Masters, Journ. Linn. Soc., vol. 31, p. 346, fig. 21 (1896); Sargent, Silva N. Am., vol. 10, p. 107, t. 527 (1896); Veitch, Man. Conif., p. 204 (1900); Jepson, Fl. W. Mid. Cal., p. 25 (1901).

Shrub or small tree, branching from near the base and forming a compact crown 8 to 15 feet high; bark grayish brown and fibrous; leaves with closed dorsal pits, rarely with lateral depressions and about ½ line long; cones globose, often congested in heavy clusters, shortly peduncled, 8 to 11 lines in diameter; scales 6 or 8, with a very small low upwardly impressed crescent-shaped umbo; seeds reddish and often glaucous, acutely margined, 1½ to 2 lines long.

The Sargent Cypress grows on dry mountain slopes and is distributed from Red Mountain (southern Mendocino) to Mt. Tamalpais, Cedar Mountain (southeastern Alameda Co.), Santa Cruz Mountains, and Santa Lucia Mountains. Its localities are few and isolated. Altitudinally it occurs chiefly between 1300 and 2300 feet. It is the *Cupressus Goveniana* of the Botany of California in great part, Sargent's Silva of North America, and Jepson's Flora of Western Middle California, but not of Gordon. The above description is based in the first instance on shrubs growing on the western slope of Red Mountain. It is named in compliment to Charles S. Sargent, author of the Silva of North America.

In addition to the stations above given there is a station in San Diego County. The trees here are to be found in Cedar Cañon between El Nido and Dulzura.[33] They are exceedingly variable in their characteristics, not only in fruit characters but in the branchlets as well.

[33] These trees are referred to *Cupressus guadalupensis* Wats. by Mr. C. N. Forbes, one of my students who has prepared a manuscript revision of the North American Cypresses. He describes the branchlets as very slender and of a brilliant pea-green shade, never glaucous; the foliage with a stronger and more pungent odor than any other of our cypresses; the cones as exceedingly variable, with 6 to 12 scales, in this corresponding to the Guadalupe Island trees; the seeds large (five or more mm. long by four mm. broad), strongly angulated, of a bright salmon color, not glaucous.

In all localities, to be sure, throughout its range this species shows slight variations, so it is in this sense a polymorphic species and has thus far been too little studied to indicate completely its natural relationships.

### 4. **Cupressus Macnabiana** Murray.

McNab Cypress.

Plate 52, figs. 4, 5.

Cupressus Macnabiana Murray, Edin. New Phil. Jour., vol. 1, p. 293, pl. 11 (1855); Watson, Bot. Cal., vol. 2, p. 114 (1880); Sargent, Silva N. Am., vol. 10, p. 109, t. 528 (1896); Masters, Jour. Linn. Soc., vol. 31, p. 347, fig. 23 (1896); Purdy, Gard. & For., vol. 9, p. 233 (1896); Jepson, Fl. W. Mid. Cal., p. 25 (1901).

Shrub or tree, most commonly 15 to 25 but even 40 feet high with trunk ¼ to nearly 2 feet in diameter; bark light gray and very smooth; leaves ½ line long with a conspicuous resin-bearing pit or white gland on the back towards the apex, often slightly glaucous; cones globose, clustered, short-peduncled, 5 to 8 lines in diameter, reddish or grayish brown; scales 6 to 8 with strong conical umbos, the uppermost pair very prominent or horn-like and incurved; seeds brown, 1½ to mostly 2 lines long.

The McNab Cypress grows on dry hills or in the bottoms of cañons and is distributed from Napa County to Shasta County, thence eastward to the northern Sierras and westward into the Coast Ranges. The known localities are few and isolated. It reaches its greatest development in eastern Napa County where it is frequent in the gullies of the dry chaparral hills from Samuels Springs northwestward to Pope Valley, Butts Cañon and Coyote Valley. The largest tree measured here had a trunk five feet and two inches in circumference at three feet from the ground and was forty feet in height. It is also found northward to the neighborhood of Cobb Mountain in Lake County, being quite common on the chaparral hills between Adams Springs and Glenbrook. It occurs again on Red Mountain in southeastern Mendocino and also along Bartlett Creek in northeastern Lake County.

*Cupressus Macnabiana* was discovered by Murray and Beardsley "near Mt. Shasta" in 1854. It was not rediscovered in that region until 1900 when it was located in Shasta County by F. M. Anderson and reported in the Flora of Western Middle California in 1901. This locality is one of especial interest and concerning it Benjamin Macomber writes me as follows: "The cypress covers rather densely an area about a mile and a half square about three miles west of the town of Shasta on the road to Whiskeytown. The locality is a rather flat-bottomed one at an elevation of about 1100 feet. The trees grow thickly, in some places almost to the exclusion of everything else. They are

small and scrubby, the largest twenty to thirty feet tall and trunks a foot and a half in diameter at base."

The above villages were once prosperous mining camps located on travelled routes in gold days and doubtless the locality represents the original one. New localities have been recently reported by the Forest Service as follows: near Dobbin, Yuba County; base of Lassen Buttes; Trinity County; Seiad Creek, western Siskiyou.

### 5. **Cupressus Bakeri** Jepson.

MODOC CYPRESS.

Plate 52, fig. 7.

CUPRESSUS BAKERI Jepson, Fl. Cal., pt. 1, p. 61 (1909).

Shrub or becoming a small tree 25 feet high with red-brown bark and very slender branchlets; leaves with a distinct resin-bearing pit on middle of keeled back; staminate catkins 1 line long or less; cones globose, satiny or glaucous, 5 to 6 lines in diameter; scales 3 pair or with a fourth smaller upper pair; umbos abruptly drawn to a short point, either nipple-like or compressed, straight or slightly curved; seeds brown, 1½ lines long, narrowly wing-margined.

The Modoc Cypress grows on the lava beds of southeastern Siskiyou and southwestern Modoc counties at 4000 feet altitude where it has been collected by M. S. Baker, H. M. Hall, and others. My first specimens were received in 1900.

Concerning this tree Mr. Baker writes as follows: "It is found quite plentifully along the road through the lava bed in the extreme southeastern corner of Siskiyou County between Little Hot Spring Valley and Hills Farm on the Fall River-Sisson Stage road. The trees occur for several miles, perhaps four or five, on the eastern half of the road and quite possibly along the western half too. But they are easily passed over since they are not readily distinguished from the Juniper among which they grow, and which in general color, appearance, form and size they resemble. The lava in which they occur has the slightest soil, most of the surface being bare rock. Still it supports quite a forest of scrub Yellow Pine, Knob-cone Pine, and Juniper. The cypress trees are about the size of the junipers but more symmetrical. The branches are long, becoming shorter upward and so giving a rapid taper to the outline of the tree. I would say from memory that they did not exceed eighteen inches in diameter at the base, nor forty feet in height. This stretch of lava on which the cypress occurs is an arm ten to twenty miles wide extending southward from the great lava field in Siskiyou and Modoc. I have crossed this arm about fifteen miles farther northward several times without noticing this tree, but unless one

looks carefully at every tree the cypress would be mistaken for juniper, the fruit being about the only character the eye readily distinguishes. I have also made many trips into Siskiyou and Modoc lava fields farther north without noticing it."

## 5. Juniperus L. Juniper.

Trees or shrubs. Leaves in whorls of 3 or opposite, scale-like, imbricated, closely appressed and adnate to the branchlets or linear-subulate and spreading. Stamens and ovules on separate trees. Staminate catkins with many stamens, each with 2 to 6 anther cells. Ovulate catkins of 3 to 6 succulent coalescent scales, each bearing 1 or 2 ovules. Cones fleshy and berry-like, ripening the second year, in ours 1 to 3-seeded; cotyledons 2 to 6.—Northern hemisphere, about thirty species.

### Key to the Species.

Catkins axillary; leaves linear-subulate, spreading, white-glaucous above; subalpine shrub ..... 1. *J. communis.*

Catkins terminal on short branchlets; leaves scale-like, closely appressed to the branchlets in whorls of 3 or opposite.

Berries reddish brown, oblong; cotyledons 4 to 6; medium altitudes ..... 2. *J. californica.*

Berries blue-black, globose or subglobose.

Cotyledons 4 to 6; desert ranges ..... 3. *J. utahensis.*

Cotyledons 2; high Sierras ..... 4. *J. occidentalis.*

1. **Juniperus communis** L., var. **montana** Ait. Dwarf Juniper. Low or prostrate alpine shrub, 1 foot high or less, forming patches a few feet in diameter; leaves rigid, linear or lanceolate, acute, cuspidate, 3 to 6 lines long, 3 (rarely 2) at a node with very short internodes, spreading or ascending, green below, white-glaucous above; staminate catkins 1½ to 2¼ lines long, their scales broad and abruptly contracted into a short subulate point; berries globose, bright blue, covered with white bloom, 1½ to 2½ lines long.

The Dwarf Juniper is found at an elevation of 8000 to 9500 feet in the high Sierra from Mono Pass and Desolation Valley near Lake Tahoe to Mt. Shasta, thence westward to Del Norte County. It ranges north to Alaska and far eastward and is widely distributed over the entire northern hemisphere. In the eastern United States it sometimes takes on an erect shrub form or even occurs as a small tree.

## 2. **Juniperus californica** Carr.

### California Juniper.

Plate 52, fig. 9.

Juniperus californica Carrière, Rev. Hort. 1854, p. 352, fig.; Rothrock, Bot. Wheeler, p. 375 (1878); Watson, Bot. Cal., vol. 2, p. 113 (1880); Palmer, Am. Nat., vol. 12, p. 593 (1878); Kellogg, For. Trees Cal., p. 14 (1882); Merriam, N. Am. Fauna, no. 7, p. 340 (1893); Parish, Zoe, vol. 4, p. 352 (1894); Coville, Bot. Death Val. Exped., p. 224 (1893); Sargent, Silva N. Am., vol. 10, p. 79, t. 517 (1896); Jepson, Fl. W. Mid. Cal., p. 25 (1901).

Usually a shrub, much-branched from the base, 2 to 20 feet high, or occasionally a tree 40 feet in height; bark brown or ashen gray, the thin outer layers becoming at length very loose and shreddy; leaves in threes, ovate, acute, each with a dorsal pit towards the base, crowded on the ultimate branchlets or occasionally free and subulate, ½ to 1 line long; ovulate catkins consisting of 4 to 6 scales; berries reddish or brownish, almost smooth or roughened with a few small projections or horn-like processes, covered with a dense white bloom, subglobose or oblong, 4 to 8 lines long, with dry fibrous sweet flesh and 1 to 3 seeds; seeds ovate, acute, brown with a thick smooth but angled or ridged polished bony shell, 3 to 5½ lines long; embryo 2⅓ lines long with 4 to 6 cotyledons.

The California Juniper, known also locally as "White Cedar," "Sweet-berried Cedar," and "Sweet-fruited Juniper," lives on dry hills and mountain slopes between 400 and 4000 feet and is distributed from Moraga Pass and Diablo southward to Tres Pinos, Mt. San Carlos, Soledad near Saugus Cañon, San Gabriel Wash, San Bernardino Valley, eastern base of San Jacinto, and Lower California. Also in the Sierra Nevada at lower altitudes as far north as Kernville and Mariposa. It occurs as scattered individuals or in thin groves, usually in erect form although sometimes prostrate. On Mt. Diablo towards the eastern head of Mitchell Cañon low mounds of this juniper about three feet high and ten to fifteen feet broad are to be seen on the exposed southern slopes at 2300 feet altitude. Sargent attributes this species to the valley of the lower Sacramento, where, we feel confident, it does not occur. No definite locality has as yet been reported from the North Coast Ranges, although the shrubs along Elk Creek, a tributary of the Stony in Glenn County, are in all likelihood the California Juniper but no specimens have thus far come to us.[34] It is also probable that the juniper reported as growing in the hills west of Scott Valley, Lake County, belongs here.

The heart-wood is reddish brown and sap-wood clear white. It has essentially the same physical properties as the Sierra Juniper and is used for similar purposes.

[34] Sudworth (For. Trees Pac. Slope, p. 189) cites a number of localities in this region.

It was first collected by M. Boursier de la Rivière, a French traveler in California, doubtless between 1849 and 1853. William Lobb also collected it and it was by him introduced into English cultivation in 1852 or thereabouts, but proved unsuitable to European conditions.

3. **Juniperus utahensis** Lemmon. DESERT JUNIPER. Small or stunted shrub 3 to 15 or rarely 20 feet high; very similar to the California Juniper, but distinguishable by its more slender branches, its usually glandless leaves which are acute and sometimes in whorls of two and its usually globose berries which are blue-black with a whitish bloom and 4 to 5 lines long, resembling those of the Sierra Juniper but the cotyledons 4 to 6.

The Desert Juniper wholly replaces the California Juniper in the arid region of the Great Basin between the Rocky Mountains and Sierra Nevada where it is abundant in the plateau valleys at 5000 feet altitude or on the mountain ranges up to 8000 feet, most commonly forming pure groves. It enters California in the Death Valley region, occurring on the Charleston, Inyo, Panamint, Grapevine, and White mountains between 5000 and 6000 feet.

## 4. **Juniperus occidentalis** Hooker.

SIERRA JUNIPER.

Plate 52, fig. 8.

JUNIPERUS OCCIDENTALIS Hooker, Fl. Bor. Am., vol. 2, p. 166 (1839); Endlicher, Syn. Con., p. 26 (1847); Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 142 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 59, pl. 10 (1857); Watson, Bot. Cal., vol. 2, p. 113 (1880); Kellogg, For. Trees Cal., p. 13 (1882); Coville, Bot. Death Val. Exped., p. 225 (1893); Parish, Zoe, vol. 4, p. 353 (1894); Sargent, Silva N. Am., vol. 10, p. 87, t. 521 (1896); Veitch, Man. Conif., p. 178 (1900); Muir, Mts. of Cal., p. 204 (1901); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 540 (1900).

Subalpine tree 10 to 25 or even 65 feet high; trunks 1 to 5 feet in diameter, the bark dull red, flaking off in thin scales or shreds; branchlets alternate, the ultimate ones small, numerous, congested; leaves in 3s, ½ line long, ovate-triangular, bearing on the back a more or less distinct gland or pit, or on vigorous shoots subulate and 1 to 2 lines long; staminate catkins 1½ to 2 lines long, 6 pollen-sacs under each peltate scale; berries globose to ovoid, blue-black with a whitish bloom, 3 to 5 lines long, almost smooth or minutely umbonate, with resinous juicy flesh and 2 seeds (rarely 1 or 3); seeds flat on the face, the convex back with 3 to 5 resinous-glandular pits; embryos ¾ to 1 line long, with 2 cotyledons.

The Sierra Juniper inhabits high rocky ridges and granite beds and is distributed through the Sierra Nevada, southward to the San Bernardino Mountains, northward to Mt. Shasta, thence southward in the Coast Ranges to South Yollo Bolly and Mt. St. John; also eastward to the Rocky Mountains. Although growing as low as 4500 feet in some places it is most common and reaches its largest size in the high Sierras at 7000 to 10,000 feet altitude, where it is found almost everywhere on exposed granite slopes as a scattered growth averaging but a few trees to the acre, and is a characteristic feature of the scenery at timber line. With the crowns beaten by storms into irregular shapes, often dead on one side but flourishing on the other, the tops usually dismantled and the trunks excessively thickened at base, such figures whether erect, half-overthrown or wholly crouching, are the most picturesque of montane trees and are frequently of very great age. The struggle of this tree with the elements has been strongly interpreted from a personal standpoint by John Muir in several fine passages in the "Mountains of California." In protected localities they present regular figures forty-five to sixty-five feet high with trunks sometimes six or seven feet in diameter at the ground.

The wood is light, soft, close-grained and very durable. It is used for fuel, posts, fence-rails, and machine bearings. "White Juniper," "Yellow Cedar," and "Red Cedar" are names in local use but the latter two are botanically improper and otherwise unfortunate designations for this species.

## TAXACEAE. Yew Family.

Trees or shrubs with linear leaves, 2-ranked by a twist in their petioles. Stamens and ovules borne on different trees and appearing in early spring from axillary scaly winter buds. Stamens united by their filaments into a column with 4 to 9 pollen-sacs pendent from each filament. Ovule solitary, terminal on a short axillary branch. Seeds set loosely in a fleshy cup, or quite surrounded by it and thus appearing drupe-like.

### Key to the Genera.

Fruit scarlet; stamens 8 to 10 in a cluster; leaves ½ to ⅔ inch long, acute at apex, without resin-canal ..... 1. Taxus.

Fruit green or purplish; stamens 24 to 32 in a cluster; leaves 1¼ to 2½ inches long, stiffish, bristle-pointed, the resin-canal central ..... 2. Torreya.

## 1. Taxus L. Yew.

Trees or shrubs with 2-ranked linear leaves. Stamens 8 to 12 in a cluster, the 4 to 9 pollen-sacs borne under a shield-like crest. Ovule seated upon a circular disk which in fruit becomes cup-shaped, fleshy and red, surrounding the bony seed, the whole berry-like. Cotyledons 2.—Northern hemisphere, 1 species and 6 subspecies.

### 1. **Taxus brevifolia** Nutt.

Western Yew.

Plate 33, figs. 4, 5.

Taxus brevifolia Nuttall, Sylva, vol. 3, p. 86, t. 108 (1849); Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 140 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 60, 90, fig. 26 (1857); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 26, 69 (1860); Watson, Bot. Cal., vol. 2, p. 110 (1880); Kellogg, For. Trees Cal., p. 7 (1882); Lemmon, 3rd Rep. Cal. Board For., p. 185, t. 30 (1890); Sargent, Silva N. Am., vol. 10, p. 65, t. 514 (1896); Veitch, Man. Conif., p. 142 (1900); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 535 (1900); Jepson, Fl. W. Mid. Cal., p. 17 (1901); Goddard, Univ. Cal. Publ. Am. Archae., vol. 1, p. 32 (1903).

*Taxus Lindleyana* Murray, Edin. New Phil. Jour., vol. 1, p. 294 (1855).

Small tree, 15 to 30 feet high, rarely exceeding 40 feet, irregular in outline, the branches of unequal length and standing at various angles but tending to droop; trunk ½ to 2 feet in diameter, with a thin red-brown smooth bark which becomes shreddy as it flakes off in thin and rather small pieces; leaves linear, acute at apex, shortly petioled, flat with midrib in relief above and below, 3 or mostly 6 to 8 lines long, 1 line wide, spreading right and left in flat sprays; stamen clusters globose, 1 to 1½ lines long; seeds borne on the under side of the sprays and when mature set in a fleshy scarlet cup, the whole looking like a brilliantly colored berry 5 or 6 lines long.

The Western Yew grows along streams in the cool depths of mountain cañons and is distributed from Santa Cruz County northward through the Coast Ranges to Mt. Shasta, thence southward through the Sierra Nevada to Tulare County at elevations of 2500 to 5000 feet, and northward to British Columbia and Montana. It has long been attributed to Monterey County, California, but no exact station is on record. First discovered by David Douglas on the lower Columbia River in 1825, it was also observed a few years later by Nuttall in the "dense maritime forests of Oregon."

The localities in California throughout its range are comparatively few and scattered while the individuals in a locality are, likewise, generally few and scattered, never occurring as a forest or scarcely even as a grove. It is by no means a common tree. It occurs in the Redwood Belt of the Santa Cruz

Mountains and throughout the Redwood Belt of the North Coast Ranges. In the North Coast Ranges it also occurs east of the Redwood Belt and farther and farther eastward as one goes northward. The scattered files of the trees are found along most sheltered streams in Mendocino County where trees with trunks two feet in diameter near the ground are sometimes found. I have seen it on Elk Creek, near Sylvandale, in Sherwood Valley, near Cahto, Laytonville, Cummings, on the saddle between Bells Spring and Seward Ranch Ridge, and between Three Creeks and Redwood Creek. Not elsewhere have I seen it so abundant as in the Shelley Creek bottom in Del Norte County, where there is a narrow grove several miles long, most of the trees fifteen to twenty-five feet high with trunks six inches to one foot in diameter. In the Coast Ranges it is found most frequently between 1500 and 2300 feet, but it occurs at 6000 feet on the Kelsey Trail across the Klamath Range in the company of the Weeping Spruce.

The wood is strong, heavy, hard, bright red, and very close-grained. The native tribes made their strong bows for war and hunting from Yew saplings, as also spear handles and fish-hooks from its wood; the white man prizes the wood for pulleys, machine-bearings, tool handles, wedges, mauls, and fence-posts. The ranchmen dress the wood green. It is exceedingly durable in contact with soil, and settlers on the river benches of the Eel unearth and make use of the buried drift logs which must be centuries old. It was at one time more common than now in the cañons about Mt. Shasta. Robert Brown, who traveled in southern Oregon in 1865, says the Oregon Indians prize as much a bow of Shasta Yew as in Europe used to be prized a coat of Uhlan steel or a Toledo blade. Indeed, tough elastic Yew wood from the Shasta region was a product of barter and sale along the trade routes of the native tribes of California far to the southward.

The stamen-clusters appear in May or June, crowded on the under side of the branches, containing 8 to 12 stamens, each stamen with 4 to 9, usually 5 or 6, pollen-sacs. The berries ripen in July or August; the pulp is not poisonous although the seed is said to be.

### 2. Torreya Arn.

Trees with rigid sharp-pointed leaves in 2 ranks. Stamen clusters solitary in the adjacent leaf axils, borne on 1-year-old branches, made up of 6 to 8 whorls of stamens, 4 stamens in a whorl, each filament with 4 pollen-sacs without crests. Ovule completely covered by a fleshy aril-like coat, the whole becoming drupe-like in fruit. Seed with thick woody outer coat, its inner layer irregularly folded into the white endosperm. Cotyledons 2.—Four species, 1 in California, 1 in Florida, and 2 in China and Japan.

## 1. Torreya californica Torr.

CALIFORNIA NUTMEG.

Plate 53.

TORREYA CALIFORNICA Torrey, N. Y. Jour. Pharm., vol. 3, p. 49 (1854), Pac. R. Rep., vol. 4. pt. 5, p. 140 (1856); Bigelow, Pac. R. Rep., vol. 4, pt. 5, p. 24 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 61, fig. 27 (1857); Bolander, Proc. Cal. Acad., vol. 3, p. 228 (1866); Watson, Bot. Cal., vol. 2, p. 110 (1880); Kellogg, For. Trees Cal., p. 5 (1882); Veitch, Man. Conif., p. 117 (1900).

*Torreya Myristica* Hooker, Bot. Mag., t. 4780 (1854); Gordon, Pinetum, p. 327 (1858).

*Tumion californicum* Greene, Pitt., vol. 2, p. 195 (1891); Sargent, Silva N. Am., vol. 10, p. 59, t. 513 (1896); Jepson, Fl. W. Mid. Cal., p. 18 (1901); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 535 (1900).

Handsome dark green tree 15 to 90 feet high, the trunk ½ to 3 feet in diameter and clothed in smoothish thin dark bark; leaves rigid, 1¼ to 2½ inches long, 1½ lines wide, flat, dark green above, yellowish green beneath and with two longitudinal glaucous grooves, linear or somewhat tapering above, the apex armed with a stout short bristle, twisted on their short petioles so as to form a 2-ranked flat spray; stamen clusters whitish, globose, about 3 lines long, crowded on the under side of the branches; fruit elliptical in outline, resembling a plum or olive, green in color or when ripe streaked with purple, 1⅛ to 1¾ inches long; flesh thin and resinous; shell of the seed more or less longitudinally grooved; embryo minute (a line long), placed at the upper end of the seed; endosperm copious, with irregular incisions filled by the inner coat, giving it a marbled appearance so that in cross-section the seed resembles the true nutmeg of commerce.

The California Nutmeg, one of the most singular as well as one of the most handsome of Californian trees, grows along the borders of streams or in creek bottoms or on moist mountain sides in both the Coast Ranges and Sierra Nevada. Although widely distributed, it is forestrally a rare tree, the individuals usually scattered or but few in a place and most commonly of small size, that is, mere shrubs or at most small trees fifteen to twenty feet high. In the Sierra Nevada it occurs between 2000 and 5000 feet and is known from the following localities: South Fork Kaweah; East Fork Kaweah; Mariposa Big Trees; Yosemite; Hetch-Hetchy; Webber Creek; San Antonio Creek; South Fork of Mokelumne River; Empire Creek (tributary of the American). In the Coast Ranges it is found in the Santa Cruz Mountains, Mt. St. Helena Range, and seaward Coast Range from Tamalpais northward to Ukiah and Sherwood Valley, and at one time existed in the Vaca Mountains. Away from the coast the species is invariably of small size, always met with as a mere shrub or at most small trees fifteen to twenty or rarely thirty feet high. It is only in the

main Redwood Belt along the coast that individuals seventy to ninety feet high and three to four feet in trunk diameter are found. The finest trees known stand in Sonoma County in the neighborhood of Duncan Mills, and formerly large-sized specimens grew along Papermill Creek in Marin County and on the Mendocino coast. There are some fair-sized trees in Archibald Creek Cañon, Santa Cruz Mountains, one being eighty-five feet high and two feet six inches in trunk diameter.

The wood is light, soft, strong, close-grained, strongly odorous, with white sap and clear light yellow heart-wood susceptible of a fine polish. It is, however, too rare to be of commercial importance although highly adapted for fine work. In early days backwoodsmen often selected the trees for their rough bridges on account of the remarkable durability of the wood, which on account of its odor they call Stinking Yew.

The catkins appear in June and July. The fruits, or "nuts," which ripen in September and October, are usually elliptic, but sometimes globose (Hy-ampum Mt.), or long and tapering toward the base (as seen on Mt. Tamalpais trees). They were gathered for food by the native tribes and highly esteemed. When roasted the kernel is palatable with an aromatic flavor. The California Nutmeg is, however, not at all related, either biologically or economically, to the nutmeg of commerce (*Myristica fragrans* Houtt.).

The discoverer of our species is not known. Specimens gathered on the "headwaters of the Feather and Yuba rivers" in the Sierra Nevada were communicated to Dr. Torrey of Columbia College in 1853, but the collector's name was not given. Since that time its range and botanical characteristics have been fairly well worked out. It is strictly confined to California and of all our forest trees none other is so scarce in individuals and so likely to become quite unknown in its aboriginal adult form.

# ANGIOSPERMS.

Sexual reproductive organ called the flower, typically consisting of a shortened branch bearing whorls of floral envelopes (calyx and corolla) and essential organs (stamens and pistil). Calyx or corolla, or both, often absent. Stamens and pistils in the same or in different flowers. Stamen consisting of a filament bearing an anther or pollen-sac. Pistil consisting of an ovary or sac, which always encloses the ovules, and a style and stigma.

### Monocotyledons.

Leaves parallel-veined, without stipules. Stem not increasing in diameter by definite rings. Tap-root none. Flowers with the parts in 3s or multiples of 3, the perianth commonly not differentiated into calyx and corolla, often absent. Embryo with one cotyledon.

## LILIACEAE. Lily Family.

Perennial herbs, the stems from bulbs, corms or root-stocks, scape-like with basal leaves or leafy and branching, rarely trees. Flowers regular, perfect, the perianth with 6 lobes or 6 distinct segments, the 3 outer nearly like the 3 inner, or very unlike, all often colored alike. Stamens 6, sometimes 3, rarely 4. Ovary superior, 3-celled; style 1. Fruit a capsule or rarely a berry.

### 1. Yucca L. Spanish Bayonet.

Trees or shrubs with simple or branched stems. Leaves alternate, linear-lanceolate. Flowers large, in terminal panicles, the perianth segments distinct, nearly equal, withering-persistent. Stamens 6. Fruit a capsule, either dry and dehiscent, or somewhat fleshy and indehiscent. Seeds numerous, in 2 rows in each cell, flat, horizontal, with thin black coat.—The flowers are incapable of self-pollination, each Yucca species being dependent upon a particular moth or species of Pronuba. The female Pronuba works by night, collecting the pollen from the anthers and rolling it into a little ball; she then flies to the flower of another plant, deposits her egg in the ovary, and then in a manner which seems to indicate that her actions are full of purpose and deliberation climbs to the style and thrusts the pollen ball far down the stigmatic tube. The larva

destroys about a dozen seeds, but even if several larvae develop, many perfect seeds are left.

KEY TO THE SPECIES.

Trunk at summit branching freely; leaves serrate on margin; stigma sessile, 6-lobed ..... 1. *Y. brevifolia.*

Trunk simple or shortly branched; leaves smooth on margin; style short, 3-lobed ..... 2. *Y. mohavensis.*

## 1. **Yucca brevifolia** Engelm.

TREE YUCCA.

Plate 54.

YUCCA BREVIFOLIA Engelmann in Watson, King's Rep., vol. 5, p. 496 (1871); Parish, Zoe, vol. 4, p. 349 (1894).

*Yucca arborescens* Trelease, Rep. Missouri Bot. Gard., vol. 3, p. 163, pls. 5, 49 (1892); Sargent, Silva N. Am., vol. 10, p. 19, t. 502 (1896).

Tree commonly 20 to 30 feet high with an open crown of arm-like branches, the columnar trunk 8 to 15 feet high and 1 to 3 feet in diameter; flowers greenish white; stigma 6-lobed; fruit oblong-ovate, slightly 3-angled, 2 to 4 inches long and 1½ to 2 inches broad.

The Tree Yucca inhabits arid mesas and mountains and is distributed from the western arm of the Mohave Desert to Walker Pass at 5000 feet (where it descends into the Kern River Valley) and Coso Mountains near Owens Lake, thence eastward through southern Nevada to southwestern Utah. The trees form in many places, notably on the Mohave Desert, scattered groves where they impart to the desert landscape a singularly weird appearance. The stem does not branch until after the first flowering and is densely clothed with stiff spiny serrate leaves, all of which point upwards. After the plant flowers, the old leaves die, turn outwards and downwards, falling in one or two years, and the trunk branches from lateral buds formed beneath the terminal flower bud.

The wood is very light and will not split and is highly adapted for surgeon's splints. Immersed in tepid water and bandaged to the limb the splint retains the form thus given it. Moreover its porous character allows free circulation of air. The pulp of the trunks was at one time manufactured into paper, but the project proved unprofitable and was abandoned. C. Hart Merriam states that a Mohave wood rat cuts off the bayonet-like leaves near the base and uses them with other sharp and thorny material to form a barrier about the mouth of its hole as a protection against coyotes and other animals. The name Joshua Tree was given it by the Mormons of southern Utah, but it is more frequently called Tree Yucca in California.

### 2. **Yucca mohavensis** Sarg.

MOHAVE SPANISH DAGGER.

YUCCA MOHAVENSIS Sargent, Gard. & For., vol. 9, p. 104 (1896), Silva N. Am., vol. 10, p. 15, t. 500 (1896).

*Yucca baccata* Engelmann, Trans. St. Louis Acad., vol. 3, p. 44 (1873), in part; Watson, Bot. Cal., vol. 2, p. 164 (1880), in part; Parish, Gard. & For., vol. 4, p. 136 (1891).

Stemless on the coast, or towards the interior with a simple or shortly-branched trunk up to 15 feet in height and ½ foot in diameter; sometimes two trunks from a common base; leaves concave, light yellow-green, entire on the margin; flowers in a panicle 1 to 1½ feet long; style 3-lobed; fruit 3 to 4 inches long and 1½ inches thick, usually constricted about the middle.

The Mohave Spanish Dagger is scattered over desert mountain slopes and plateaus from southern Nevada and northeastern Arizona across the Mohave Desert, thence southward to western San Diego County and westward to the coast, which it follows as far north as Monterey County. Fibres, says Palmer, were manufactured from the leaves by the native tribes of the desert who wove them into blankets or cords.

## PALMACEAE. PALM FAMILY.

Commonly trees with fibrous roots and columnar unbranched trunks covered with leaf-scars or the bases of leaf-stalks and bearing a tuft of large leaves at summit. Leaves sharply plaited when young, eventually tearing more or less along the lines of the folds. Flowers commonly monoecious, borne in a large inflorescence enclosed by a spathe. Perianth very inconspicuous, with 3 to 6 equal segments. Stamens commonly 6. Carpels 3, separate or united, each 1-ovuled. Fruit a berry, drupe or nut.

### 1. WASHINGTONIA Wendl. FAN PALM.

Trees with fan-shaped much folded leaves and long petioles armed with stout hooked spines along their margins. Flowers perfect. Fruit a berry.—Three species: *W. Sonorae* Wats. of Sonora, Mexico; *W. gracilis* Parish, cultivated in California gardens and doubtless native of northern Lower California; and the following.

## 1. **Washington filifera** Wendl.

### California Fan Palm.

Plates 6, 55.

Washingtonia filifera Wendland, Bot. Zeit., vol. 37, p. 68 (1879); Watson, Bot. Cal., vol. 2, p. 211 (1880); Parry, S. F. Bulletin, Mar. 24, 1881; Parish, Gard. & For., vol. 3, p. 51 (1890), Zoe, vol. 4, p. 349 (1894), Bot. Gaz., vol. 44, p. 408 (1907), vol. 48, p. 462 (1909).

*Pritchardia filamentosa* Drude, Bot. Zeit., vol. 34, p. 807 (1876); Palmer, Am. Nat., vol. 12, p. 598 (1878).

*Washingtonia filamentosa* O. Kuntze, Rev. Gen. Pl., vol. 2, p. 737 (1891).

Columnar tree 20 to 75 feet high, the trunk 1 to 3 feet in diameter at the enlarged base, covered with a scaly rind and sometimes clothed quite to the ground with a thatch of dead persistent recurved leaf-bases; leaves fan-shaped, 3 to 6 feet long, with 40 to 60 folds, torn nearly to the middle, the divisions copiously fibrous; petioles 2 to 5 feet long, very stout; flowers perfect, borne in a branched panicle on long stems, the whole 8 to 12 feet long; calyx tubular; corolla funnel-shaped with the stamens inserted on its tube; berries borne on pedicels 1 to 1½ lines long, black, oval, 3 to 3½ lines long, with thin flesh surrounding a large seed which is flattened somewhat on the ventral side; endosperm horny.

The California Fan Palm grows along alkaline streams, rivulets or springs on the western and northwesterly margins of the Colorado Desert (a one-time inland sea) and thence southward to Lower California. They are abundant and of fine size in four cañons at Palm Springs, beginning on the east with Palm Cañon, where there are perhaps one hundred trees, Lukens Cañon with about fifty or sixty, Murray Cañon, upwards of a hundred, and Andreas Cañon, perhaps thirty or thirty-five. "Up the narrowing arm of the desert towards Banning, twelve miles west of Palm Springs, opposite Whitewater Ranch and just east of Snow Creek, pouring down the precipitous north side of San Jacinto Peak, is a side cañon or tributary of Snow Creek with about a dozen big palms in it," according to M. French Gilman, forest ranger. He also says that about seven miles farther west is a little cañon, also on the side of San Jacinto, with a tiny trickle of alkali water in it, where stood two palms probably twenty feet high. Some years ago one was cut down and when Mr. Gilman last visited the spot he found that some vandal had destroyed the remaining one.

On the western side of the Colorado Desert are several localities south of Palm Springs. There are two trees at Piñon Flats in a cañon which opens on to the desert at Indian Wells. This station is at an altitude of 3000 feet. In the lower part of Coyote Cañon are a number of trees where, at a place called "Los Coyotas," the natives thatch their huts with the leaves. South of this

there is a locality at "Palm Cañon" near San Ysidro Mountain and another at Seventeen Palms about thirteen miles southeast of Clark Well.

These palms also inhabit "rincons" or curved recesses at the base of the mountains on the north side of the desert from Salton westward to Whitewater. The place names, Dos Palmos, One Hundred Palms, Thousand Palms (meaning a large number), indicate the localities for palms or their one-time habitats. Whitewater Cañon, the most westerly locality on the north side of the desert, supports several large palms.

To the Indian tribes of the Colorado Desert this tree was of great economic importance. They used the leaves to thatch their huts, while the three or four clusters of fruit borne by a tree, each weighing about ten pounds, were an important source of food supply. In order to get up the tree the more readily they were accustomed to burn off the dead reflexed leaves. All the old trees in Palm Cañon show the signs of such burnings. Palmer says the Indians ate, also, the soft bases of the young leaves.

### Dicotyledons

Leaves netted-veined. Stem increasing in diameter by an annual layer of wood inside the bark Flowers with the parts in 4s or 5s, the perianth commonly differentiated into calyx and corolla, sometimes absent. Embryo with 2 cotyledons.

## SALICACEAE. Willow Family.

Trees or shrubs of rapid growth, light wood and bitter bark. Leaves simple and alternate, with stipules. Flowers dioecious, arranged in catkins, these falling off as a whole, the staminate after shedding the pollen, the pistillate after ripening of the fruit and dispersion of the seeds. Bracts of the catkin scale-like. Calyx and corolla none. Stamens 1 to many. Ovary 1-celled; stigmas 2 to 4. Fruit a 2- to 4-valved pod, enclosing many seeds furnished with a tuft of hairs at base.

Key to the Genera.

Bracts entire or merely denticulate, persistent; flowers without disk; stamens usually 1 to 5; stigmas short ..... 1. Salix.

Bracts fimbriate or lacerate, caducous; flowers with a broad disk; stamens usually numerous; stigmas elongated or conspicuously dilated ..... 2. Populus.

### 1. Salix L. Willow.

Trees or shrubs with mostly narrow short-petioled leaves. Winter buds covered by a single scale. Catkins mostly erect, appearing before or with the leaves; bracts entire or merely denticulate, persistent. Staminate flowers with

1 to 9 stamens and 1 or 2 little glands. Pistillate flowers with a gland at the base of the ovary. Stigmas 2, short.—One hundred and sixty species, mainly of the north temperate and arctic regions.

Adequate scientific field studies and collections, a necessary preliminary to herbarium work, are yet to be made of our willows. We have of both trees and shrubs seventeen known species; while it is probable that the number of species will be increased through the discovery of northern forms in the high mountains, at the same time one or two of our imperfectly known local species may be homologized with northern types.

KEY TO THE SPECIES.

Stamens 3 to 9, their filaments hairy or woolly below; style short; stigmas roundish, subentire; scales pale or yellowish, in the pistillate catkin more or less deciduous by maturity; capsules pediceled; trees, mainly of lower altitudes.

Petioles with wart-like glands at summit; leaves lanceolate, long-pointed; stipules usually present, roundish; catkins in bud tapering, in flower usually straight, their scales erect ..... 1. *S. lasiandra.*

Petioles not glandular; stipules usually absent; catkins in bud cylindric.

Leaves broadly lanceolate, acute, usually glaucous beneath; staminate catkins curving; scales reflexed or spreading ..... 2. *S. laevigata.*

Leaves very narrow, nearly alike on both faces, finely serrulate, often curving towards apex ..... 3. *S. nigra.*

Stamens 2, their filaments woolly or hairy below; scales pale, somewhat deciduous; catkins borne on short leafy branchlets, often clustered; leaves linear or lanceolate; shrubs of stream beds at lower altitudes.

Stigmas linear, raised on a distinct style; ovary densely silky; leaves silvery or green ..... 4. *S. sessilifolia.*

Stigmas oblong or roundish, sessile.

Capsule glabrous; leaves green, remotely serrulate ..... 5. *S. longifolia.*

Capsule more or less pubescent; leaves more or less white-silky, entire.... Var. *argyrophylla.*

Stamens 2 (rarely 1), their filaments glabrous; stigmas entire or notched, rarely parted into linear lobes; scales usually black or dark-colored; scales mostly persistent.

Capsules glabrous.

Leaves dark green above, white-pubescent beneath; catkins sessile, leafless; filaments more or less united; small tree or shrub; foothills mainly, common ..... 6. *S. lasiolepis.*

Leaves light green, nearly alike on both faces; catkins shortly peduncled and leafy bracteate; filaments distinct or partly united; montane, rare with us ..... 7. *S. cordata.*

Capsules tomentose, silky or puberulent.

Style none.

Leaves obovate; catkin-scales black, with white hairs ..... 8. *S. flavescens.*

Leaves lanceolate; catkin-scales tawny ..... 9. *S. macrocarpa.*

Style evident.

Stamen 1, or if 2 the filaments partly united; stigmas linear; leaves conspicuously silky beneath ..... 10. *S. sitchensis.*

Stamens 2; stigmas short.

Montane species; good-sized shrubs; leaves entire or nearly so.

Leaves glabrate beneath; catkins appearing with the leaves, borne on short leafy peduncles; Sierra Nevada ..... 11. *S. Lemmonii.*

Leaves glaucous-pubescent beneath, long and narrow; catkins appearing before the leaves, sessile; inner South Coast Range ..... 12. *S. Breweri.*

Alpine species; low shrubs or dwarfs.

Capsule shortly pediceled, at least pistillate catkins on short leafy peduncles.

Ovary hoary or finely tomentulose.

Leaves entire, usually green and glabrate ..... 13. *S. glauca.*

Leaves serrulate, usually gray-villous, the bract-like leaves glandular-serrulate ..... 14. *S. californica.*

Ovary glabrous; leaves bright green, dark-veined ..... 15. *S. Barclayi.*

Capsule sessile, 2 lines long; catkins short, sessile or subsessile ..... 16. *S. monica.*

Capsule subsessile, 2 to 3 lines long; catkins terminal on short leafy branches; plant body forming a more or less dense mat ..... 17. *S. tenera.*

## 1. **Salix lasiandra** Benth.

### Yellow Willow.

Plate 56, figs. 1-3.

Salix lasiandra Bentham, Pl. Hartw., p. 335 (1857); Watson, Bot. Cal., vol. 2, p. 84 (1880); Sargent, Silva N. Am., vol. 9, p. 115, t. 469 (1896); Jepson, Fl. W. Mid. Cal., p. 136 (1901).

Tree 20 to 45 feet high, the trunk with brown roughly fissured bark; branchlets one-winter-old yellowish; winter buds keeled on the back, short and blunt; young leaves lanceolate, or oblanceolate, acuminate, glandular-serrulate, with small suborbicular stipules; mature leaves lanceolate with long tapering or very slender point, 4 to 7 inches long, 5/8 to 1 1/4 inches wide; petioles 3 to 9 lines long, glandular at the upper end; stipules on vigorous shoots conspicuous, orbicular, 5 to 12 lines broad; staminate catkins 1 1/4 to 3 inches long, usually straight, 5 to 6 lines thick; pistillate catkins 1 1/4 to 2 1/4 inches long, 2 1/2 to 3 lines thick; bracts erect, oblong-lanceolate, thin, nearly or quite glabrous on the back, hairy at base, the staminate yellow, the pistillate brown and mostly deciduous in fruit; stamens 4 to 9; ovary and capsule glabrous.

The Yellow Willow, also called Waxy Willow, is widely distributed in the Coast Ranges, Great Valley, Sierra Nevada (especially in the foothills), and Southern California. The following stations are verified by my own specimens: Berkeley, 1891; Ross Valley, 1896; Olema, 50 feet, 1897; St. Helena, no. 2340; Howell Mt., 1893; Comptche, no. 2227; Bear Valley, Nevada Co., 4500 feet,

1898; Kern Cañon, 6700 feet, no. 1103; Bubbs Creek, South Fork Kings, 8500 feet, no. 787; Warthan Creek, near Priest Valley, no. 2665. The altitudinal range of this species is very considerable: on the coast it is found a few feet above sea-level as at Olema; in the Sierra Nevada it occurs as high as 4500 feet in the north and 8500 feet in the south. Beyond our borders it ranges north to British Columbia and Idaho. The first to collect it was Theo. Hartweg, who discovered it on the Sacramento River between Sacramento and Marysville. It is most easily recognized in the field by its glandular-warty petioles and long-pointed leaves. Leaves on vigorous shoots may be as much as 10½ inches long and 2 inches wide.

In the days of Alta California the "trees" of Spanish saddles were made from selected pieces of wood of this species and of the next. Such saddles were even exported to Mexico and Texas, according to Charles Howard Shinn.

### 2. **Salix laevigata** Bebb.

RED WILLOW.

Plate 56, figs. 4-6.

SALIX LAEVIGATA Bebb, Am. Nat., vol. 8, p. 202 (1874); Watson, Bot. Cal., vol. 2, p. 83 (1880); Sargent, Silva N. Am., vol. 9, p. 113, t. 468 (1896); Jepson, Fl. W. Mid. Cal., p. 136 (1901).

Forma ARAQUIPA Jepson, Fl. Cal., pt. 2, p. 339 (1909).

Tree 20 to 50 feet high, the trunk bark roughly fissured; branchlets one-winter-old reddish brown; winter buds ovate, pointed; young leaves broadly oblong, acute at each end, disposed to be broadest above the middle, mucronate, entire, soon becoming serrulate; stipules minute and caducous or none; mature leaves oblong-lanceolate to lanceolate, obtusish at base, acute at apex or sometimes long-pointed, serrulate, glabrous, green and shining above, pale or conspicuously glaucous beneath, 2½ to 7½ inches long, ⅝ to 1¼ inches broad; petioles 1 to 5 lines long; staminate catkins commonly flexuous, 1½ to 4½ inches long, 4 or 5 lines thick; pistillate catkins ¾ to 2 inches long, 2 lines thick; bracts soon spreading or reflexed, elliptic, blunt, woolly at base, glabrous and pallid towards apex, 2 to 4-toothed, the staminate yellow, the pistillate gray and tardily deciduous; stamens 4 to 7 (sometimes 3); ovary and capsule glabrous; style very short; stigmas roundish.

The Red Willow grows along living streams and is distributed through the Coast Ranges, Great Valley, and Sierra Nevada (especially the foothills) to Southern California. It is commonly an associate of the Yellow Willow and has been variously called Bebb Willow, Smooth-leaf Willow, and Spotted-leaf Willow. The following stations are verified by my own specimens: Berkeley,

1891; Moraga Valley, 1899; St. Helena, nos. 506, 2341; Howell Mt., 1893; Alamo Creek, Solano Co., nos. 538, 539, 540, 541, 542; Vaca Mountains, no. 2358; Salt Creek and Cold Fork of the Cottonwood, Tehama Co., 1899; Harding Landing, Sacramento River, 1891; Marysville Buttes, 1891; Randolph Flat, Nevada Co., 1891. Altitudinally it ranges from near sea-level to about 4500 feet altitude in the southern Sierra Nevada. It would seem too closely related to *S. Bonplandiana* H.B.K. of Lower California and Mexico. That species is evergreen, but our arboreous species are occasionally half evergreen in mild winters.

Forma **araquipa** Jepson. Small tree; one-year-old shoots with dense close tomentum; brown tuft of hairs on old wood at base of season's shoot very conspicuous; leaves reddish brown above; catkins long and dense.—Dry gulches, Araquipa Hills, Solano County, May 2-6, 1891, *W.L. J.*

### 3. **Salix nigra** Marsh.

BLACK WILLOW.

Plate 56, fig. 7.

SALIX NIGRA Marsh, Arbust. Am., p. 139 (1785); Watson, Bot. Cal., vol. 2, p. 83 (1880); Sargent, Silva N. Am., vol. 9, p. 103, t. 462 (1896); Jepson, Fl. W. Mid. Cal., p. 136 (1901).

Var. VALLICOLA Dudley in Abrams, Fl. Los Angeles, p. 100 (1904). *S. vallicola* Britton, Trees N. Am.

Var. *venulosa* Bebb in Bot. Death Val., p. 199 (1893).

Tree commonly 20 to 40 feet high, with rough dark bark; branchlets brittle at the base; mature leaves lanceolate or linear-lanceolate, long-pointed, often falcate, serrulate, glabrous, green on both surfaces, 2 to 7 inches long, 2 to 4 (or 8) lines wide; petioles 1 line long; stipules early deciduous; scales of catkins obovate, yellow, hairy, erect; staminate catkins 1½ to 2½ inches long; stamens 3 to 5; pistillate catkins ¾ to 1¼ inches long, in fruit 1 to 2½ inches long, becoming rather lax; ovary scantily pubescent or hoary; capsule glabrous, reddish brown.

The Black Willow inhabits river banks in the Sacramento and San Joaquin valleys and follows the desert rivers through southeastern California and across southern Arizona to New Mexico and thence eastward to Texas and the Mississippi Valley, ranging as far north as Lake Superior and New Brunswick. It has a more extensive range than any other tree in the United States except the Aspen and is one of the two California trees in common with the silva of eastern North America, the other being the Aspen.

The following Californian specimens are before me: Red Bluff, *W.L. J.*, 1899 (the most northerly recorded station on the Pacific Coast); Cache Creek,

*C. F. Baker;* Kaweah River near Lemon Cove, *W.L. J.,* 1900; Fort Mohave, *Cooper;* Cameron Lake, Colorado Desert, *Brandegee.* Leaves sometimes 6½ inches long and ¾ inch wide.

Var. **vallicola** Dudley. Peduncles tomentose; stamens 5 to 11; stigmas 2-lobed.—Santa Ana River, Orange Co., *Abrams.*

4. **Salix sessilifolia** Nutt. Sandbar Willow. Shrub with slender stems 5 to 14 feet high forming clumps in river bottoms; foliage silvery or becoming more or less green; leaves linear, usually tapering to the acute apex and to the narrow but short petiole-like base, entire, 1 to 3 inches long, 2 to 4 lines broad, thinly villous on both surfaces and green, or densely villous and silky, especially on young or sterile shoots; no stipules; catkins on leafy peduncles; staminate catkins ⅓ to 1 inch long, slender (2 lines thick), in bud usually cylindric, the scales with acute green tips; gland long and slender; pistillate catkins ¾ to 1 inch long, 3 lines broad, often not dense; ovary sessile, densely silky; style present, stigmas linear; capsule densely silky, or glabrescent and brown.

Abundant in stream beds of the Coast Ranges, Great Valley, and Sierra foothills northward into Oregon. The following localities may be noted: Klamath River, Humboldt Co.; Ukiah; Santa Rosa Valley; Napa Valley; Pacheco; Weldon Cañon, Vaca Mountains; Putah Creek; Sacramento; Sutter County; Salt Creek fork of the Cottonwood, Tehama County; Red Bluff. (*S. Parishiana* Rowlee is a synonym).

5. **Salix longifolia** Muhl. Long-leaf Willow. Shrub 5 to 8 or 15 feet high with bright green foliage; leaves mostly glabrous, or sometimes minutely canescent, lanceolate or linear, tapering to apex and to a short petiole at base, remotely serrulate with cuspidate teeth, ¾ to 5 inches long, 2 to 4 lines broad; catkins terminal on leafy branches; staminate catkins ½ to 1⅛ inches long, 2 lines thick; pistillate catkins ½ to 1 inch long; ovary pediceled or sometimes nearly sessile, glabrous; stigmas very short, sessile; scales densely woolly; capsule glabrous; fruiting catkin 1¼ to 2½ inches long.

Stream beds in the foothills and valleys throughout the State and into the mountains to 4000 feet. The following localities may be noted: Hupa Valley; Lake County; Vaca Mountains; Putah Creek; Butte County; San Jacinto Mountains; Tehipite Valley; Yosemite Valley. (*S. fluviatilis* Nuttall? *S. exigua* Nutt. *S. Bolanderiana* Rowlee.)

Var. **argyrophylla** And. Coyote Willow. Slender shrub, stem one from the base, strictly erect or sometimes straggling, 4 to 12 feet high; foliage lustrous silvery or glabrescent and green; leaves linear, acute at apex or long-pointed, entire, ¾ to 2½ inches long, 1 to 2 lines wide; catkins on leafy peduncles; staminate catkins ⅓ to 1⅛ inches long, 3 lines thick, in bud usually conical, the green-tipped scales often abruptly acute; pistillate catkins ⅓ to ¾

inch long, 1½ to 2 lines thick; ovary silky; stigmas oblong, sessile, the top of the ovary sometimes bulbous-dilated just below them; capsule glabrescent, brown.

Stream beds in the valleys and foothills throughout California. The following localities may be noted: Priest Valley; Oxnard; San Jacinto Valley; Amador County. M. E. Jones' observations, in his recent paper[35] upon the intergrading character of *S. sessilifolia* Nutt., *argophylla* Nutt., and *longifolia* Muhl. are very just. The relations of *S. argophylla* are at present little understood and its exact status is very uncertain.

### 6. **Salix lasiolepis** Benth.

ARROYO WILLOW.

Plate 56, figs. 8-10.

SALIX LASIOLEPIS Bentham, Pl. Hartw., p. 335 (1857); Watson, Bot. Cal., vol. 2, p. 86 (1880); Sargent, Silva N. Am., vol. 9, p. 139, t. 481 (1896); Jepson, Fl. W. Mid. Cal., p. 137 (1901).

Var. BIGELOVII Bebb in Bot. Cal., vol. 2, p. 86 (1880).

*Salix Bigelovii* Torrey, Pac. R. Rep., vol. 4, p. 139 (1857).

*Salix franciscana* Seeman, Bull. Torr. Bot. Club, vol. 30, p. 634 (1903).

*Salix Bakeri* Seeman, l.c., p. 635.

Shrub or tree 10 to 18 or rarely 35 feet high, the trunk 3 to 7 inches in diameter with smooth bark; mature leaves oblong, obovate or linear, acute, obscurely serrulate, dull green and glabrous above, white-pubescent or pale beneath, 1½ to 5 inches long, ⅓ to 1¼ inches broad; petioles 1 to 8 lines long; catkins appearing before the leaves, sessile, densely silky tomentose in the bud, suberect; scales dark; staminate catkins ¾ to 1½ inches long, 5 to 6 lines thick; stamens 2, filaments glabrous, more or less united below; pistillate catkins ¾ to 1 inch long, 3 to 4 lines thick, in fruit 1½ to 2¼ inches long; style medium, stigmas 2; capsule glabrous or puberulent, short-pediceled.

The Arroyo Willow, sometimes called White Willow, grows on the banks of living streams in valleys and cañons, and also follows the winter flood-streams into the foothills where it is the common and often the only willow on the banks of summer-dry arroyos. It is distributed from northern California southward through the Coast Ranges, Sierra Nevada foothills, and Great Valley to Southern and Lower California. Typically an inhabitant of the foothills, it ranges occasionally to altitudes of 4000 feet. While having the reputation of being an exceedingly variable willow yet its eccentricities are rather easily comprehended because very divergent states, especially leaf forms, may be collected

[35] Jones, Willow Family of the Great Plateau (1908).

from a single individual. Easily included here is *S. Bakeri* Seeman. The bark towards the base of trunks of old trees is often roughish or checked. *Salix lasiolepis* was first discovered by Hartweg on the Salinas and Carmel rivers near Monterey in 1846.

Var. **Bigelovii** Bebb. Leaves broadly obovate or cuneate-oblong, obtuse entire, ¾ to 1⅜ inches broad; catkins on short leafy peduncles.—San Francisco, first collected by Bigelow (*S. Bigelovii* Torr., *S. franciscana* Seeman).

7. **Salix cordata** Muhl. var. **Mackenziana** Hook. Mackenzie Willow. Shrub; leaves oblong-lanceolate, narrowed to the subcordate or truncate base and tapering into the pointed apex, entire or serrulate, glabrous, light green above, often glaucous beneath, 1 to 2½ (or 4) inches long, ½ to ¾ (or 1½) inches broad; petioles 1 to 3 lines long; stipules orbicular, early deciduous or none; catkins subsessile or shortly peduncled, especially the pistillate, sparingly leafy-bracted, dense, 1 to 1½ inches long, 3 to 4 lines thick; scales narrow, dark or black, the lower part villous with long white hairs; stamens 2, filaments glabrous, elongated, free or more or less united; style long, stigmas short, bifid; fruiting catkins 1 to 1¾ inches long; ovary and capsule glabrous; pedicel 1 line long.

High mountains: Sierra Nevada (Mariposa and Calaveras counties); Lake County (according to Bebb) and far northward. Apparently rare in California. Our form has shorter and less leafy peduncles than the type of the Rocky Mountains.

Var. **Watsonii** Bebb. Branches smooth, polished, yellow; leaves dark-green, smaller, oblong, short-acuminate, serrulate or subentire, 1 to 3 inches long; stipules small or none; catkins 1 inch long, crowded.—High montane, 6000 to 9000 feet: San Jacinto Mountain, northern Sierra Nevada and eastward to Utah.

### 8. **Salix flavescens** Nutt.

Nuttall Willow.

Plate 56, figs. 11-13.

Salix flavescens Nuttall, Sylva, vol. 1, p. 65 (1842), not of Host; Bebb, in Bot. Cal., vol. 2, p. 86 (1880), in part.

*Salix Nuttallii* Sargent, Silva N. Am., vol. 9, p. 141, t. 482 (1896), Man., p. 184 (1905). Var. *brachystachys* Sargent; Jepson, Fl. W. Mid. Cal., p. 137 (1901).

Shrub 2 to 15 feet high or a small tree 25 feet high; branchlets commonly with very dark bark; leaves broadly obovate or oblong-obovate, entire, rounded at apex or shortly acute, 1 to 1½ (or 4) inches long, ½ to 1½ inches broad, yellow-green and lustrous above, yellow-veined, glabrate or densely short-silky beneath; petioles 4 lines long; catkins appearing before the leaves, oblong or

elliptic, ½ to 1 inch long, 5 to 7 lines thick, sessile; bracts obovate, rounded at apex, black or black-tipped, covered with white hairs; stamens 2, conspicuously long-exserted, filaments glabrous; ovary white-silky; style none, stigmas broadly linear, sometimes notched at apex; capsule less silky than the ovary.

The Nuttall Willow grows in the Sierra Nevada from 4000 to 10,000 feet, southward to the San Bernardino Mountains, north to British Columbia and throughout the Rocky Mountains in the United States. Along the coast of California it occurs from Santa Barbara and Monterey to Mendocino and Humboldt and northward beyond our borders in Oregon and Washington, where it is abundant and of large size (seventy feet high) in swamp and bottom lands on the coast. On the California coast it is usually a small straggling bush growing about springs on steep north slopes in cañons as in the Oakland Hills and Santa Cruz Mountains, although in the latter region it also occurs as a tree twenty-five feet high with trunk nine to eighteen inches in diameter. I do not find even varietal difference between Coast and Sierra forms. In the Sierra Nevada considerable variations appear, some of which match the coast form, *S. brachystachys* Bentham, type locality of which is Monterey.

9. **Salix macrocarpa** Nutt. var. **argentea** Bebb. Silver Willow. Slender shrub 6 to 16 feet high with numerous stems from the base and very slender branchlets; leaves lanceolate, acute at base, acuminate at apex, 1 to 1½ inches long, 2 to 5 lines wide, becoming green above, appressed silky beneath and imparting a silvery sheen, or glabrate and pale; petioles 1 to 3 lines long; catkins short-peduncled with 2 or 3 leafy bracts, the staminate 4 to 6 lines long and 3 lines thick, the pistillate 3 to 4 lines long and 1½ to 2 lines thick; scales dark or yellowish, rounded; filaments glabrous; style none or very short; ovary hoary; stigmas ovate, entire or emarginate; fruiting catkins ½ to ¾ inch long, about as thick; capsules 2 to 3 lines long, light brown, puberulent, pediceled.

Sierra Nevada, 7000 to 9000 feet: Volcano Creek, common in and about the meadows in the Whitney region, *W.L. J.*, no. 952; Mono County, *Congdon,* and northward to Oregon and Idaho. The specific name, *macrocarpa,* is misleading. (*S. Geyeriana* And.)

### 10. **Salix sitchensis** Sanson.

Velvet Willow.

Salix sitchensis Sanson, Bongard, Veg. Sitch., p. 162 (1833); Bebb, in Bot. Cal., vol. 2, p. 87 (1880); Sargent, Silva N. Am., vol. 9, p. 149, t. 486 (1896); Jepson, Fl. W. Mid. Cal., p. 137 (1901). Forma Coulteri Jepson, Fl. Cal., pt. 2, p. 342 (1909). Forma Ralphiana Jepson, Fl. Cal., l.c. Forma parvifolia Jepson, Fl. Cal., l.c.

Var. angustifolia Bebb in Bot. Cal., vol. 2, p. 87 (1880).

*Salix Coulteri* Anderson; Bebb, in Bot. Cal., vol. 2, p. 90 (1880).

Arborescent or shrubby, 5 to 25 feet high, the trunk 2 to 10 inches in diameter; leaves obovate to oblanceolate, rounded or shortly acute at apex, entire (obscurely serrulate on vigorous shoots), dark green and almost glabrous above, densely tomentose and lustrous silky beneath, 2 to 5 inches long, 1 to 3 inches broad; petioles 1 to 6 lines long; stipules small, early deciduous or on sterile shoots broad or orbicular, 4 to 6 lines long; staminate catkins 1¼ to 2 inches long, 5 to 6 lines thick; stamens 1, or exceptionally 2 and their filaments more or less united; pistillate catkins ¾ to 2 inches long and 3 lines thick, or in fruit 3 to 5 inches long; bracts covered with long white silky hairs, the staminate rounded at apex, the pistillate shorter, broader and more acute; style elongated, stigmas short-oblong, entire or nearly so.

The Velvet Willow occurs in the Sierra Nevada and in the Coast Ranges from Santa Barbara to Mendocino, thence northward to Oregon and southeastern Alaska. In the Coast Ranges it occurs only in the immediate neighborhood of the coast and is comparatively uncommon. The following localities may be noted: Santa Lucias; Pacific Grove; Kings Mountain, San Mateo County; Mt. Tamalpais, Marin County; Sonoma Creek near Mt. Hood; Caspar; Eureka. It was first collected at Sitka by the Russian botanist, Dr. R. H. Mertens.

Forma **Coulteri** Jepson. (*S. Coulteri* And.) Leaves coriaceous, densely woolly beneath, 2 to 3 inches long; stipules 3 or 4 lines long.—San Francisco, *Bolander*, no. 2451, and southward.

Forma **parvifolia** Jepson. Leaves oblanceolate, acute, ¾ to 1¼ inches long, 3 to 4 lines broad; stipules minute.—Melburne to Comptche, Mendocino County, *W.L. J.*, no. 2229.

Forma **Ralphiana** Jepson. Leaves narrowly oblong, white beneath with a fine dense felt, 2 to 3½ inches long, 6 to 10 lines wide; stipules small; catkins about 2 inches long.—Marble Fork of the Kaweah, 6900 feet, *W.L. J.*, no. 690. Named for Ralph Hopping, naturalist on the Kaweah North Fork.

Var. **angustifolia** Bebb. Leaves narrowly oblanceolate, acute or acuminate, 1 to 2 inches long, 3 to 4 lines wide, the margin revolute; stipules none; fruiting catkin 1 inch long.—Donner Pass, according to Bot. Cal.

SALIX HOOKERIANA Barratt, of the Oregon coast, a related species with glabrous capsules, may be expected in Del Norte County.

11. **Salix Lemmonii** Bebb. LEMMON'S WILLOW. Shrub 5 to 13 feet high; leaves lanceolate, acuminate at both ends, entire, green, nearly alike on both faces, glabrous or nearly so, dark-veined, 1 to 1½ lines long, 3 lines broad; petioles 1 or 2 lines long; stipules small, soon deciduous; catkins ½ inch long on very short peduncles with 2 or 3 foliaceous bracts; scales pitch-black, usually rounded, villous; stamens 2, filaments slightly puberulent at base; style short,

stigmas short-linear, entire; ovary and capsule grayish tomentose or the latter glabrate; pedicels in fruit ½ to ¾ line long.

Sierra Nevada, 7000 to 8000 feet altitude from Mariposa County, *Congdon*, northward to Plumas County and Washoe County, Nevada; Wasatch Mountains, Utah, acc. Jones; eastern Oregon, *Cusick*. First collected by J. G. Lemmon, a pioneer Californian botanist, in Sierra County. The staminate flowers exceptionally bear four stamens, the filaments partly united in pairs, or one pair distinct.

*S. Austinae* Bebb was founded on a mixture of material representing two or three species. (Bebb, Bot. Gaz., vol. 16, p. 106.)

12. **Salix Breweri** Bebb. Brewer Willow. Shrub; young leaves oblong, shortly acute, entire, white-pilose above but soon becoming green except along the midrib, white below with a close tomentum, ⅝ to 1 inch long, 2 to 3 lines wide; mature leaves green and puberulent above, rugose beneath and whitened with a thin but dense felt-like covering, entire, 2 to 2½ inches long, 3 to 4 lines wide; petioles almost none; stipules of sterile shoots small, ovate, acute; catkins appearing before the leaves, dense, ¾ inch long, 3 to 4 lines thick, sessile, with 2 or 3 small bracts at base; scales yellow, rounded at apex, rather densely pilose on both sides; stamens 2; filaments glabrous; nectary filiform, very long; ovary and capsule hoary; style elongated, stigmas 2-cleft.

San Carlos Range: Mt. San Carlos, *W. H. Brewer,* no. 788, July 23, 1861, 3500 feet altitude; headwaters of San Benito River, *W. L. Jepson,* no. 2709, May 12, 1907, 4000 feet altitude, low crouching shrub along water's edge.

13. **Salix glauca** L. var. **villosa** And. Shrub 2 to 4 feet high; leaves oblong-lanceolate, acute or taper-pointed, entire, green above, slightly glaucous beneath, pubescent or subglabrous, when young villous tomentose, 1 to 2½ inches long, 3 to 7 lines wide; petioles almost none to 3 lines long; stipules lanceolate or none; catkins ½ to ¾ inch long, on leafy-bracteate peduncles, the staminate peduncles very short or almost none; scales hairy, dark, turning reddish; stigmas entire or 2-lobed; fruiting catkins ¾ to 1½ inches long; ovary hoary or tomentulose; capsule brown, finely pubescent, 3 to 4 lines long.

Sierra Nevada, 8000 to 11,000 feet altitude: Farewell Gap, *W.L. J.*, no. 1150; Bullfrog Lake, S. Fork Kings, *W.L. J.*, no. 851; San Joaquin, S. Fork, *Hall & Chandler;* Chilnualna Trail, Mariposa County, *Congdon*, northward and far northward. (*S. glaucops* And.)

14. **Salix californica** Bebb. Sierra Willow. Shrub 2 to 5 feet high, very near the preceding; leaves mostly oblong, acute at apex, obtuse at base, appressed-villous and gray (or the young parts densely white tomentose), often glabrescent and green, finely glandular serrate, ¾ to 2 inches long, 5 to 9 lines broad; margin of small leaves at base of both leafy and flowering shoots thickly

studded with glands; stipules ovate, lanceolate or none; catkins on short leafy peduncles, the staminate ½ inch, the pistillate ½ to 1 inch long (in fruit 1 to 1½ inches long); scales dark, villous; ovary hoary-tomentose; style elongated, stigmas oblong, bifid or entire; capsule brown, finely pubescent, 2 to 3 lines long.

Sierra Nevada, 7000 to 9000 feet: House Meadows on North Fork Kings River; Mt. Goddard; Crescent Lake, Mariposa County; Yosemite National Park; Soda Springs of the Tuolumne; Summit, Placer County; near Mt. Lola, Nevada County. No more than a subspecies or variety of the preceding, it is distinguishable only by its glandular-serrate leaves. Entire leaves are, however, sometimes found on the same branch as serrate leaves.

15. **Salix Barclayi** And. Barclay Willow. Dwarf shrub; leaves white-tomentose when young, soon green, dark-veined, narrowly obovate, obtuse or bluntly acute, tapering to the shortly petioled base, entire or sometimes serrulate, ½ to 1½ inches long; catkins on short leafy peduncles, dense, ¾ to 1½ inches long, 4 to 5 lines broad, the scales very black and covered with long white pilose hairs; stamens 2, filaments sometimes united one-third their length; ovary and capsule glabrous or nearly so, green, pediceled; style long, stigmas 2-lobed.

Subalpine, Marble Mountain, Siskiyou County, 6000 feet; Warner Mountains, Modoc County; northward into Oregon and far northward.

16. **Salix monica** Bebb. Mono Willow. Procumbent or erect branching shrub, 1 to 5 feet high; branchlets dark red; leaves ovate, acute at apex, acutish at base, ostensibly entire but obscurely and remotely serrulate, bright green above, somewhat pale below, glabrous or nearly so, ⅓ to 1½ inches long, 3 to 7 lines broad, rather conspicuously feather-veined, the veins dark or black; petioles 1 or 3 lines long; stipules none; scales roundish ovate, hairy; catkins small and short, densely flowered, sessile or subsessile; bracts none or few and small; fruiting catkins ¾ inch long; style medium sized, stigma usually entire; capsule brown, glabrate, subsessile, 2 lines long.

Mono Pass, Mono Co., *Brewer,* no. 1732 (1863), *Congdon* (1894); Soda Springs of the Tuolumne, *Congdon* (1898); Yosemite National Park, *Katherine Jones* (1897). Obscure and little known species, possibly referable to some northern type.

17. **Salix tenera** And. Alpine Willow. Stems with very short, often tortuous branches forming a depressed or prostrate plant body 1 to 4 inches high; flowering shoots 1 to 6 inches high; leaves oblong and acute, ovate-lanceolate, entire, scantily pilose, ¼ to 1 or 1½ inches long, 2 to 5 lines broad; catkins on erect leafy peduncles, densely flowered, ⅓ to ¾ inch long, the pistillate

1 to 2 inches long; peduncles in fruit 1 to 2 inches long; style long, stigmas 2-cleft; capsules white woolly or glabrescent and brown, subsessile, 2 to 3 lines long.

Sierra Nevada, 9000 to 11,000 feet: Mt. Whitney (southernmost locality), Mt. Brewer, Mt. Goddard, Mt. Lyell, Mt. Dana, and other high peaks and far northward to the Arctic circle. (*S. arctica* Pallas var. *petraea* And. *S. petrophila* Rydb.)

### 2. Populus L. Poplar.

Trees with scaly buds and caducous stipules. Leaves rather long-petioled, broad. Winter buds covered by many scales. Catkins appearing before the leaves, in ours pendulous; bracts fimbriate or lacerate, caducous. Stamens inserted on the surface of a concave disk. Ovary seated on a collar-like disk; style short; stigmas 2 to 4, narrow and elongated, or conspicuously dilated. Capsule 2 to 4-valved. Coma of the small seeds long and conspicuous.—Eighteen species, north temperate zone.

Key to the Species.

Stamens 40 to 80.

Leaves deltoid-orbicular, broader than long, yellowish green, alike on both faces; valley streams ..... 1. *P. Fremontii.*

Leaves longer than broad, ovate, dark green above, rusty or silvery beneath; valley and mountain streams ..... 2. *P. trichocarpa.*

Stamens 6 to 12; leaves round-ovate, 1 to 2 inches long; high mountains ..... 3. *P. tremuloides.*

### 1. **Populus Fremontii** Wats.

Common, or Fremont, Cottonwood.

Populus Fremontii Watson, Proc. Am. Acad., vol. 10, p. 350 (1875), Am. Jour. Sci., ser. 3, vol. 15, p. 136 (1878); Watson, Bot. Cal., vol. 2, p. 92 (1880); Kellogg, For. Trees Cal., p. 97 (1882); Havard, Gard. & For., vol. 3, p. 620 (1890); Coville, Bot. Death Val. Exped., p. 200 (1893); Merriam, N. Am. Fauna, no. 7, p. 335 (1893); Sargent, Silva N. Am., vol. 9, p. 183, t. 496 (1896); Jepson, Fl. W. Mid. Cal., p. 138 (1901).

Variety *Wislizenii* Watson, Am. Jour. Sci., ser. 3, vol. 15, p. 136 (1878), Bot. Cal., vol. 2, p. 92 (1880); Pringle, Gard. & For., vol. 1, p. 105, fig. (1888); Parish, Zoe, vol. 4, p. 348 (1894); Sargent, Silva N. Am., vol. 9, p. 184 (1896), whom the writer follows in his reduction of this variety.

*Populus monolifera* Torrey, Sitgreaves, Rep., p. 172 (1853), not Aiton; Coville, Bot. Death Val. Exped., p. 200 (1893).

Handsome tree commonly 40 to 90 feet high, the trunk short or long, 1 to 5 feet in diameter and parting into wide-spreading limbs which form a massive

crown; bark white or whitish, on the main trunk 1 to 5 inches thick, roughly cracked; leaves triangular or roundish in outline, 2 to 4 inches broad, broader than long, the margin crenate except at the abruptly short-pointed apex and the truncate or subcordate base; bracts regularly laciniate-fringed, shorter than the flowers, falling as soon as released by the elongation of the catkin; staminate catkins at length 2 to 4 inches long, densely flowered, each flower consisting of 48 to 72 stamens on a disk; pistillate catkins 2 inches long (becoming twice as long in fruit), loosely flowered, each flower consisting of an ovary sinuously and strongly ridged about its middle and crowned with 3 or 4 roundish stigmas; mature pods ovate, roughish on the surface, 4 to 5 lines long, borne on pedicels 2 lines long, opening by 3 or 4 valves; seeds copiously provided with long white hairs which soon involve the catkin in a soft cottony mass.

The Common Cottonwood, or more specifically the Fremont Cottonwood, is common in Southern California, ranges southward into Lower California and northern Mexico, eastward to western Texas and southern Colorado, and northward through the Coast Ranges, San Joaquin Valley, Sacramento Valley, and Sierra foothills. In the North Coast Ranges the tree becomes very rare, although there are a few scattered individuals between Petaluma and Ukiah, especially in the cañons along the upper courses of the Russian River and its main branches. A tree at the Russian River bridge near Ukiah is ninety-five feet in height. It also occurs sparingly on the forks of the Eel River in northern Lake County (Gravelly Valley) and near Round Valley in Mendocino County.

I have never observed this species in a wild state in Napa Valley nor in the Trinity region. I have never found it distinctly associated with Redwood and it probably never enters the Redwood Belt proper. It is a common tree in the Sacramento Valley. Trees of good size are found along the branches of Cottonwood Creek, in Tehama County, particularly on Cold Fork. The most northerly station is near Redding. Captain Fremont, after whom the species was named, collected his specimens on Deer Creek, "at Lassens," in Tehama County.

*Populus Fremontii* is most abundant in the San Joaquin Valley (10 to 500 feet altitude) and probably attains its greatest size on the fertile, well-watered Kaweah delta. It ascends the southern Sierra Nevada to 3000 feet, being noted by the author at Shin Oak Camp on the South Fork of Kaweah River. Along the San Jacinto River it ascends to about 3000 feet. Along the Mohave River on the desert it is abundant, but the trees are low.

The wood is soft, light, coarse-grained with light-brown heart-wood and whitish sap-wood. It warps badly and is rarely milled, but is sometimes sawn into box lumber in Southern California.

In the sparsely wooded regions where this species is most abundant, it is one of the most important sources of fuel. Mexicans never cut down the tree but

pollard it by cutting off the main branches and thus insure a continuous crop. The small, straw-colored branchlets in the crown of a Cottonwood are continually killing each other by over-crowding with the result that the falling of the dead ones covers the ground with a litter of pencil-like twigs. Even these may not be wasted. While the ponies are grazing in the cienaga, the desert wayfarer uses this litter for the smallest of camp-fires in the heat of summer noontime, an economy of fuel which is in picturesque contrast to the appalling waste in the northern coast woods.

The inside bark is pliable and tough and is one of the Indian sources of fibres for weaving and may sometime be utilized by the white man for a similar purpose. Along the Colorado River the Indian women at one time, says Dr. V. Havard, wore petticoats woven from the fibres of this inner bark.

Cottonwood is often cultivated for shade in interior valleys and it is deserving of more frequent use as a roadside tree on those plains where there is sufficient moisture to support it. In the San Bernardino Valley it has been used for a windbreak. In the cities of northern Mexico double rows line each side of the street; it is the Alamo of the Mexicans and Spanish-Californians, and it is only avenues of Populus species that are, strictly speaking, alamedas.

Under natural conditions the Fremont Cottonwood reproduces itself abundantly by seedlings and in favorable years seizes new territory by extending for many miles along flood-streams of the dry plains. Conversely in a series of dry years this growth will be killed out more or less completely from such intermittent streams as, for example, on the west side of the southern San Joaquin.

Large-sized Cottonwood trees are often hung with the cables of the wild California Grape Vine but are seldom smothered by its foliage. The most insiduous enemy of the Cottonwood is neither the grape nor man but a parasite. There are in California two kinds of mistletoe prevalent, a dark green species (*Phoradendron villosum* Nutt.) which inhabits the Blue Oak and other hardwood trees and a yellow-green species (*Phoradendron flavescens* Nutt.) which thrives on the Cottonwood and other soft-wood broad-leaved trees. Cottonwood trees sometimes carry enormous loads of the mistletoe bunches which eventually kill them. Along many of the interior streams one may find the trees dead or dying from the attacks of the parasite which infests them.

Dependent upon an abundant supply of water and a dry atmosphere, Fremont Cottonwoods are the characteristic trees of stream banks in the most arid parts of the Southwest. Growing almost exclusively in the beds or on the banks of ever-flowing streams and lifting their great crowns of yellowish green foliage into the desert sunlight, they are landmarks across the treeless level of long stretches of sand or parched summer plains and the certain sign of water, either on the surface or a short distance below, the most precious of all things to man when traveling in a dry country.

## 2. **Populus trichocarpa** Torr. and Gray.

### Black Cottonwood.

Populus trichocarpa Torrey and Gray, in Hooker, Icon., vol. 9, pl. 878 (1852); Watson, Bot. King, p. 328 (1871), Bot. Cal., vol. 2, p. 91 (1880); Sargent, Gard. & For., vol. 5, p. 277, fig. 52 (1892), Silva, N. Am., vol. 9, p. 175, t. 493 (1896); Coville, Bot. Death Val. Exped., p. 200 (1893); Parish, Zoe, vol. 4, p. 348 (1894); Jepson, Fl. W. Mid. Cal., p. 138 (1901); Sheldon, For. Wealth Ore., p. 20 (1904). Forma ingrata Jepson, Fl. Cal., pt. 2, p. 346 (1909).

Var. cupulata Watson, Am. Jour. Sci., vol. 115, p. 136 (1878).

*Populus angustifolia* Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 29, 68 (1860), not James.

Tree 30 to 100 feet high, with a broad head of upright branches supported by a trunk 1 to 3 feet in diameter; bark light or dark but usually with a yellowish cast, longitudinally fissured, the long, narrow and rather smooth-surfaced plates separated by cleanly channeled fissures; leaves broadly or narrowly ovate, finely serrate, truncate or heart-shaped at base, acute or tapering to a point at apex, 2½ to 7 (or even 10½) inches long, lustrous green above, rusty-brown beneath when young but at length whitish; staminate catkins 1 to 2 or eventually 5 inches long, each flower with 40 to 60 stamens on a slightly one-sided disk; anthers light purple; pistillate catkins loosely flowered, 2½ to 3 inches long and 4 to 10 inches long in fruit; ovary crowned by 3 dilated and deeply lobed stigmas; pod nearly sessile, 3-valved; seeds with long lustrous white hairs.

Black Cottonwood, which is sometimes called Balm or Balsam Cottonwood on account of the balsamic foliage, grows in disconnected patches or as scattered individuals along streams or on borders of lakes. It inhabits the Sierra Nevada between 3000 and 8000 feet where it is most common in such valley cañons as the Kern, Kings, and Yosemite. It grows also on the headwaters of the Sacramento River (near Sims), the banks of the Shasta, Klamath, and Salmon rivers, the high slopes of Trinity Summit, and ascends the waters of the main Eel from near the ocean at Ferndale, following the branches of that stream as it ramifies Humboldt County and the northwestern part of the county of Mendocino and northern Lake County. While many localities are known west of the divide of the inner North Coast Range (Yollo Bolly Mountains), it has not been reported from the east slope and probably does not occur, in any event, in that portion of the inner North Coast Range from the Vaca Mountains some distance north.

In the South Coast Ranges it is found in Mitchell Cañon (Mt. Diablo), in cañons on both slopes of the Santa Cruz Mountains, along the main stream of the Pajaro River and its branches in the Gilroy Valley, inhabits stream beds on both the lower eastern and western slopes of the Santa Lucia Mountains (San Antonio, Big Sur, and Carmel rivers), and extends southward to the

southern slopes of the Sierra Madre and San Bernardino ranges, the western side of Mt. San Jacinto at 6000 feet, and finally appears on the northerly side of Palomar at Cootca, which is its most southerly reported station on the mainland. Three of the Santa Barbara Islands, namely Santa Rosa, Santa Cruz, and Santa Catalina, number this species in their insular floras.

The localities for the Black Cottonwood are not, comparatively speaking, numerous and the growth in any one locality is not extensive or abundant. Yet it is widely distributed over California and occurs in every mountain range excepting those of the Colorado Desert. It is, furthermore, noteworthy because its altitudinal range in the same latitude is greater than that of any other tree in North America. It grows in the bed of the Big Sur River in Monterey County not far from the ocean shore at about fifty feet above sea-level, associated with Redwood (*Sequoia sempervirens*) and Sycamore (*Platanus racemosa*); and near Gilroy in Santa Clara County at a little less than two hundred feet above sea-level. I have also found it in the same latitude in the Sierra Nevada on Bubbs Creek near Bubbs Dome at 8000 feet altitude, while Hall and Chandler have recorded it as occurring from 7000 to approximately 9000 feet on the South Fork of the San Joaquin. The trees of Bubbs Creek are associated with Aspen (*Populus tremuloides*) and are about 50 feet in height. It is found, too, on the floor of Yosemite Valley at 4000 feet. Northward it ranges to the Snake River and the river bottoms of British Columbia. It was first collected by Dr. C. C. Parry on the Santa Clara River near San Buena Ventura in 1850.

The Black Cottonwood is the tallest of all species of the genus Populus. It is most abundant and attains its greatest size in western Oregon and Washington. Howell gives the extreme dimensions as two hundred feet in height and eight feet in trunk diameter. The most beautiful and extensive groves in California are in Scott and Shackelford valleys in western Siskiyou. The finest grove southward is found in a little valley bottom of the Mattole River near the village of Petrolia in Humboldt County. It consists of nearly a dozen large trees, one of which is one hundred and five feet high and six feet four inches in diameter at five feet from the ground. Well-developed individuals are found on the banks of the stream which drains Long Valley in Mendocino County, one tree exhibiting a symmetrical trunk three feet three inches in diameter and unbranched for fifty feet. In the Sierra Nevada the trees are rarely more than thirty-five feet in height.

*Populus trichocarpa* is the most variable of our species in size and shape of leaf but is probably not especially variable otherwise. The following forms may be noted:

Forma **ingrata** Jepson. Leaves lanceolate, 2 to 4½ inches long, 4 to 10 lines broad.—San Bernardino Mountains, upper Santa Ana Cañon, mouth of north

fork, *H. M. Hall,* no. 7517. A singular form but connected with the usual form by easy transitions.

Var. **cupulata** Wats. Disk campanulate, pubescent, twice longer than ovary. —Plumas County, according to Bot. Cal., vol. 2, p. 91.

The wood is light, soft, fairly close-grained but not strong. The tree is too scarce in California to be of any special economic importance, but in the Columbia River coast region it has long been lumbered for the manufacture of staves, woodenware, trunks, and drawer bottoms. The tree is or was well known to the Indians of northern California. In the art of basket-making, materials for weaving on the frame are needed which combine the qualities of pliability and toughness and for this purpose the roots of the Black Cottonwood were esteemed. It is planted as a shade tree in Inyo County.

The winter-buds are slender, long-pointed, over half an inch long, the catkins bursting from them in March. All or nearly all the leaf winter-buds on the shoot of the previous season develop a rosette of leaves and continue to do so as the shoot increases in thickness, but the buds of successive seasons may add so little in length to the short branch which produces them that "spurs" often six or seven years old and only two inches long are formed. These spurs eventually die and weather off, or an occasional one may become a vigorous branch.

Black Cottonwood is a marked ornament to those valleys where it occurs in groves and to the narrow cañons where it has planted its files of trees. No traveler fails to admire its handsome foliage, dark green on the upper surface of the leaf and white beneath. Under a summer sun, with the wind flowing over the leaves, the play of colors, silver white against lustrous green, is strikingly vivid and animating.

### 3. **Populus tremuloides** Michx.

ASPEN.

POPULUS TREMULOIDES Michaux, Fl. Bor. Am., vol. 2, p. 243 (1803); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 25, 89 (1857); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 29, 68 (1860); Nuttall, Sylva, vol. 1, p. 70 (1865); Rothrock, Bot. Wheeler, pp. 51, 242 (1878); Watson, Bot. Cal., vol. 2, p. 91 (1880); Kellogg, For. Trees Cal., p. 115 (1882); Sargent, Silva N. Am., vol. 9, p. 159, t. 487 (1896); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 517, 542 (1900); Jepson, Fl. W. Mid. Cal., p. 139 (1901).

Slender tree with branches pendulous towards the ends, 10 to 60 feet high, the trunk 3 to 6 inches in diameter, bark greenish white, or on old trunks nearly black; leaves round-ovate, finely toothed or almost entire, abruptly tipped at apex with a short sharp point, 1 to 2 inches long; staminate catkins 1½ to 2½ inches long, each flower containing 6 to 12 stamens; pistillate catkins 2 to 4 inches long; ovary conical; stigmas 2, very thick below, divided above into 2

slender spreading lobes; style short and thick; seeds minute, brownish, bearing long white hairs.

The Aspen grows along streams, margins of meadows and rocky slopes from 5000 to 10,000 feet in the Sierra Nevada. It ranges north to Alaska and across the continent to Hudsons Bay and Labrador, thence southward to Maine and Kentucky. It inhabits the Rocky Mountains, northern Mexico and Arizona, occurs at only one station (Mt. San Gorgonio, at 7500 feet, on Fish Creek, *Grinnell*) in the high mountains of Southern California, and finally recurs on the isolated mountain of San Pedro Martir in Lower California. It has therefore a more extensive distribution than any other North American tree.

The southernmost reported localities in the Sierra Nevada are in the Mt. Whitney region. I have observed it on Bubbs Creek, on rocky exposed slopes of the Kern Cañon above Junction Meadow, and Coville saw it near Mineral King.

The wood is soft, whitish, fine-grained and fairly tough. It is too small a tree in California to be lumbered as it is occasionally in Oregon and Washington. In the north it is used for fence-rails and wood-pulp, and also for fuel since it burns when green and without sparks.

The Aspen, as an object in the landscape, is remarkable for its dancing leaves and their October hues. The petioles of the leaves are flattened vertically so that the equilibrium of the leaf is easily disturbed and even the slightest air-currents set the leaves a-quivering. In long, dry falls the gorgeous golden colors of the foliage is one of the greatest charms of the high Sierra forest.

## JUGLANDACEAE. Walnut Family.

Deciduous trees with alternate pinnate leaves and no stipules. Flowers monoecious. Staminate flowers borne in lateral pendulous catkins on last season's wood. Pistillate flowers solitary or few in a short terminal spike. Ovary inferior; styles 2, stigmatic along the inside. Fruit an incompletely partitioned nut containing a single oily seed and covered by a green and fleshy or, when fully ripe, a dry brown or black husk.—Six genera, widely distributed. The genus Carya of the Eastern United States is well represented by the hickories, pignuts and pecans, some of which are cultivated in California.

### 1. Juglans L. Walnut.

Bark strong-scented. Branchlets hollow, divided into little chambers by pithy partitions. Buds nearly naked. Staminate flower with an irregularly 3 to 6-lobed calyx and numerous stamens. Pistillate flower with a 4-lobed

calyx adherent to the ovary. Seed so lobed as to fit the irregularities of the nut.—Ten species, widely distributed. Four species in the United States, two in the East, a third, *J. rupestris* Engelm., occurs from Texas to Arizona. *J. regia* L., Persian or English Walnut, is extensively cultivated in California.

### 1. **Juglans californica** Wats.

California Black Walnut.

Plate 57.

Juglans californica Watson, Proc. Am. Acad., vol. 10, p. 349 (1875); Watson, Bot. Cal., vol. 2, p. 93 (1880), as to California trees; Kellogg, For. Trees Cal., p. 103 (1882); Sargent, Silva N. Am., vol. 7, p. 129, t. 337 (1895); Trelease, 7th Rep. Mo. Bot. Gard., p. 43, pl. 24, figs. 8-10 (1896); Jepson, Fl. W. Mid. Cal., p. 146 (1901), Bull. S. Cal. Acad. Sci., vol. 7, p. 23 (1908).

*Juglans rupestris* Torrey, Bot. Mex. Bound., p. 205 (1859), in part; Parish, Zoe, vol. 4, p. 345 (1894).

Tree, or often a small shrub, 10 to 70 feet high, the trunk with roughish nearly black bark; leaves pinnately compound, with 11 to 19 leaflets, 6 to 13 inches long; leaflets oblong-lanceolate, serrate, 1½ to 4 inches long; staminate catkins 2 to 4 inches long, each flower with 20 to 26 stamens; fruit globose, ¾ to 1¼ inches in diameter; nut hard, covered with a dry brown or in age black husk which does not separate from the shell or only in an irregular or partial manner; shell almost smooth, but marked with a few shallow longitudinal grooves.

The California Black Walnut inhabits the banks of streams or alluvial "washes" and has two centers of distribution: one in Southern California from Santa Barbara, *Torrey,* and the Ojai Valley to San Fernando and the Sierra Santa Monica, thence eastwardly along the foothills of the Sierra Madre to the San Bernardino Range and southward to the Sierra Santa Ana; the other in central California from the lower Sacramento to Mt. Diablo and Wooden Valley in Napa County.

In Southern California *Juglans californica* generally branches near the ground and assumes a shrub-like habit; even though it may grow to really imposing size the shrub-like habit usually persists. In describing the individuals of the southern region the term tree carries with it only the qualification of general size.

The reference to Santa Barbara as a locality on the authority of Torrey is a classical one in our literature but I have not been able to secure field verification.[36] In the Ojai Valley the species is common and may be seen to advantage on the slopes of Sulphur Mountain where it forms in company with *Quercus*

[36] It occurs on the watersheds of the Santa Maria, Santa Inez, and Santa Barbara rivers (Sudworth, Trees of the Pacific Slope, p. 208).

*agrifolia*, its most constant associate, open groves of much interest. The trees are mostly fifteen to forty feet high.

The largest tree as yet reported from Southern California stands in the upper Ojai Valley, in very deep and rich soil, at an altitude of 1300 feet. The diameter of the crown is ninety-two feet and all the lower limbs creep on the ground. The circumference of the trunk at the base is fourteen feet five inches. The lowest limb puts out at less than two feet from the ground and is fifty feet long; at the base it is four feet five inches in circumference. This limb is not a fork of the trunk but is merely a side limb, which is shown by the fact that at five feet from the ground the circumference of the trunk is twelve feet eight inches. According to the testimony of H. J. Dennison, on whose ranch the tree stands, it bears each season enormous quantities of nuts.

In the foothills of the Sierra Madre in Southern California we have both large trees and small bush-like trees only six or eight feet high. Near Covina the trees, as usually, branch low (within two or three feet of the ground) and are often so much gnarled as to resemble the Coast Live Oak or Encina with which they are associated. The largest trees average twenty-five to fifty feet in height, and measure four to nine feet around the trunk at one foot above the ground. The trees are most abundant and of largest size in the locality known locally as the "Walnut Wash." They are also met with twenty to twenty-five feet high, in the Hollenbeck Pass (San José Hills) in the same local region.

On the southern slope of the San Bernardino Mountains the California Walnut occurs from 2500 to 4000 feet as a shrub at most twelve to sixteen feet high, according to Parish, and also occurs below 2500, following the washes out some distance from the mountains within a few miles of San Bernardino (1800 feet). There are trees on the east side of the Puente Hills near the road which crosses the hills from Whittier to Puente, and in Brea Cañon; also in Santa Ana Cañon and Santiago Cañon, Santa Ana Mountains, the latter being the southernmost known locality.

The status of *Juglans californica* in northern California is rather different. On the banks of the lower Sacramento River it forms tall, round-headed trees forty to sixty feet high, with a trunk diameter of one or two feet. Doubtless the finest and most symmetrical trees have been developed in this locality. Along streams in the valleys near the western base of Mt. Diablo, as on Walnut Creek (Arroyo de los Nueces of the Spanish Californians) and Lafayette Creek the trees occur again rather frequently and illustrate the northern type. They are tall trees, fifty to seventy-five feet high, with roundish but not broad crowns supported on usually tall trunks. Heights and diameters are here given of average-sized trees growing along Walnut Creek, Contra Costa County.

| No. | Diameter at 4 feet above ground | Height |
|---|---|---|
| 1. | 1 ft. 4 in. | 60 ft. |
| 2. | 3 ft. 5 in. (at 3 ft.) | 65 ft. |
| 3. | 1 ft. | 55 ft. |
| 4. | 10 in. | 55 ft. |
| 5. | 1 ft. 10 in. | 45 ft. |
| 6. | 5 ft. | 70 ft. |

No. 6 is situated on the side bank of the stream. The original tree was felled many years ago and the diameter given is the diameter of the original stump, which persisted completely and which has since given rise to four tall, erect trunks, fourteen to twenty inches in diameter, supporting a large broad crown.

I have no record of other localities or of localities between Mt. Diablo and the Ojai Valley, and there is thus a broad gap in the distribution which is not easy to explain. Both the lower Sacramento and Walnut Creek localities are near ancient Indian village sites and it is not improbable that walnuts, like piñon nuts, were brought north along the Indian trade routes for centuries or even thousands of years before the time of Aryan discovery and settlement. Introduction from the south by the first Europeans is not an admissible theory, since some of the present trees are evidently older than the earliest Spanish exploring expeditions. Moreover, the oldest living Spanish settlers say the trees were known as wild trees to the first settlers in the country. The trees of the Walnut Creek district, as well as those of the lower Sacramento, invariably grow along valley streams (that is, in the preferred Indian as well as white man habitats of the region) and never, so far as I am aware, in the hill country on dry slopes, which is a characteristic habitat of the species in Southern California.

The most serious difficulty in assuming the native walnut to be endemic in northern California is this: The range of the species as at present understood does not follow the laws of tree distribution in California. Its distribution evidently cannot be brought into explainable relation with any other species in the manner in which, for instance, the distribution of the Digger Pine and California Buckeye or Valley Oak and Blue Oak can be correlated. The break or gap in its distribution represents an area which is as well adapted for its growth, at least in great part, as the area which it inhabits in Ventura County. Introduction into the north from the south by the native tribes seems to the writer the only plausible explanation of the problem.[37] Since the species stump-

[37] Since the above was written R. E. Smith has located (in November, 1908) a tree in Gordon Valley in the North Coast Ranges which evidently antedates white occupation and which, according to the tradition of the oldest living Spanish settlers, was planted by the Indians who possessed nuts brought from southern California. He has also brought to the writer's notice a grove of trees in the primeval broad-leaved forest of the Napa Range on the east slope in Wooden Valley, locally known to the mountain people as "Walnut Grove," and situated on an old Indian village ground. The age of one of the smaller trees was determined to be a

sprouts freely, fire could scarcely have caused its extermination over such a wide extent of country as that between Mt. Diablo and the stations in Ventura County, a region two hundred and seventy-five miles in length.

I take the southern trees to represent Watson's type. While Watson alludes in his original description to the Arizona trees and does not cite a type, the only fair and reasonable inference is that his name must first of all apply to the California trees. It is also evident that the Southern California form must be his true *californica* for several reasons: he had no northern specimens before him, his northern locality is very vague, and the description applies better to the southern form. The northern form, named var. HINDSII Jepson,[38] is characterized by its distinctly arboreous form, tall trunks and larger fruits (1¼ to 2 inches in diameter). Such differences may be readily attributable to the climatic and soil conditions of the northern habitat.

The California Black Walnut is frequently planted as a roadside tree and, about thirty years ago, was widely set out in groves or small plantations, partly for shelter and partly for the fruit. The nuts are ripe in October and contain an edible and very palatable kernel, which is however difficult of extraction on account of the hardness of the nut and its complicately chambered interior.

The growth of the tree is rapid and its symmetrical aspect pleasing. Latterly it has been used very successfully as a stock-graft for English Walnuts and it now has an established economic value for this purpose; it is thriftier than the English Walnut and its roots are better adapted to our soils.

The California Black Walnut and Eastern Black Walnut (*Juglans nigra*) are often grown near each other in cultivation, especially as street trees, and natural hybrids have resulted. In addition to the natural hybrids Mr. Luther Burbank has an artificial hybrid, "Royal", obtained by fertilizing the Black Walnut with the pollen of the California Walnut; it produces abundantly hard-shelled fruits of larger size than either parent. He has in addition originated a hybrid between the California Walnut and the English Walnut (*Juglans regia*) named "Paradox" which "grows twice as fast as the combined growth of both parents" with leaves from two to three feet in length. It is a shy bearer. The wood is described as lustrous, of silky grain, susceptible of a beautiful polish, and with annual layers one inch or more in thickness. The seedlings seen by me at his grounds in 1905 show great leaf variation,—large leaves, small leaves, many leaflets, few leaflets.

The California Walnut was first discovered by Richard Brinsley Hinds, the botanist of the British Exploring Ship *Sulphur*. The following sentences

little over one hundred years; it is probable that some of the older trees now wholly or in part replaced by new generation poles, of stump-sprout origin, represent a period of five hundred years. The endemic forest is encroaching upon these trees and if the natural conditions continue would eventually exterminate them by shade-killing. Seedling reproduction has some fifteen years since come to a standstill. These two localities, Gordon Valley and Wooden Valley, represent, then, the most northerly stations of Indian plantings.

[38] Bull. S. Cal. Acad. Sci., vol. 7, p. 23 (1908).

are taken from his brief journal, published in the preface to Bentham's "Botany of the *Sulphur*": "It was late in the autumn of 1837 when an Expedition up the Rio Sacramento penetrated from San Francisco some distance into the interior. The country exhibited a vast plain, rich in deep soil, and subject to periodical submersion. Occasional clumps of fine oaks[39] and planes[40] imparted an appearance of park land. They were already shedding their leaves; a small grape was very abundant on the banks; and we sometimes obtained a dessert from the fruit of a juglans." This is the first reference to the California Walnut and it was not until many years later that it was recognized and published as a distinct species.

*Juglans californica* is the only representative of the Walnut family on the Pacific Coast and the only species west of the Rocky Mountains, save the Texan *Juglans rupestris* which ranges west into Arizona. It is remarkable for its isolation, its restricted distribution and the comparatively small number of individuals in a locality, since it never forms a forest and but rarely a grove. The specific differences between *Juglans californica* and *Juglans rupestris* are not as yet well established.

## BETULACEAE. Birch Family.

Wind-pollinated trees or shrubs with alternate simple petioled leaves and caducous stipules. Flowers small, borne in catkins. Staminate catkins elongated, pendulous, falling after flowering, the flowers in clusters of 3 in the axil of each bract, consisting of a membranous commonly 4-parted calyx and 1 to 7 (commonly 2 or 4) stamens; bracts dilated above with the apex abruptly upturned, each covering 4 bractlets. Pistillate catkins small, erect, spike-like, the flowers 2 in the axil of each bract, without perianth, consisting of a pistil with 2 styles and a 2-celled ovary with 1 ovule in each cell. Fruit a very small compressed 1-seeded nutlet which is margined or winged.

Key to the Genera.

Pistillate catkins in clusters, forming in fruit oval or ovoid woody cones which are drooping or spreading, their scales obscurely 5-lobed at apex; stamens 1 to 7 ..... 1. Alnus.

Pistillate catkins solitary, cylindrical and erect in fruit, falling to pieces when mature, their scales plainly 3-lobed at apex; stamens 2 ..... 2. Betula.

### 1. Alnus L. Alder.

Peduncles branched or forked, bearing a cluster of few to several catkins. Calyx of staminate flower 4 (or 6)-parted; stamens 1 to 7. Pistillate catkins in clusters of 2 to 4, forming woody pendulous cones when mature, the bracts and

[39] Valley Oak (*Quercus lobata*).

[40] California Sycamore (*Platanus racemosa*).

bractlets united into 5-lobed scales which are persistent on the axis. Nutlet with a narrow acute margin.—North temperate regions, a few ranging in the high mountains to Bolivia; about eighteen species, nine in North America.

KEY TO THE SPECIES.

Catkins appearing in the early autumn as rather conspicuous naked buds, and flowering in the late winter or early spring before the leaves appear; peduncles of the pistillate catkins naked, their branches ½ inch long or less; sepals 4; stamens 1 to 4.

Trees 30 to 80 feet high; mostly of low altitudes.

Leaf-margin plane, with small scattered teeth; bracts of staminate catkin obtuse; stamens 1 to 3, rarely 4 ..... 1. *A. rhombifolia.*

Leaf-margin with narrowly revolute edge, rather coarsely toothed; bracts of staminate catkins acute or acutish; stamens 4, rarely 3 ..... 2. *A. rubra.*

Shrubs 8 to 15 feet high; leaf-margin coarsely toothed and again finely toothed; stamens 4 or 2; high montane ..... 3. *A. tenuifolia.*

Catkins appearing in the spring from scaly buds at the same time as the leaves; peduncles of the pistillate catkins leafy (at least at base), their branches ½ to 1 inch long; sepals 6; stamens 6 or 7; leaf-margin sharply or laciniately toothed; high montane shrub ..... 4. *A. viridis.*

## 1. **Alnus rhombifolia** Nutt.

WHITE ALDER.

Plate 58, fig. 5.

ALNUS RHOMBIFOLIA Nuttall, Sylva, vol. 1, p. 33 (1842); Torrey, Bot. Wilkes Exped., p. 467 (1874); Watson, in Bot. Cal., vol. 2, p. 80 (1880), in part; Parry, Bull. Cal. Acad., vol. 2, p. 351 (1887); Coville, Bot. Death Val. Exped., p. 195 (1893); Parish, Zoe, vol. 4, p. 347 (1894); Sargent, Silva N. Am., vol. 9, p. 77, t. 456 (1896); Jepson, Fl. W. Mid. Cal., p. 139 (1901).

*Alnus oblongifolia* Watson, in Bot. Cal., vol. 2, p. 80 (1880), in part.

Tree commonly 30 to 80 feet high with whitish or gray-brown bark; trunks ½ to 3½ feet in diameter; leaves 2 to 4 inches long, minutely pubescent, elliptic and obtuse, or more commonly oblong-ovate or oblong-rhombic and tapering more or less to the apex, at base broadly wedge-shaped and entire, the remainder of the margin provided with small and more or less unequal glandular teeth; staminate catkins slender, in clusters of 2 to 7, 2 to 3 (or 5) inches long; sepals 2 to 4, most commonly 3, often unequal, one usually very small when the number is 4; stamens 2, less commonly 3; pistillate catkins 3 to 7 in a cluster, erect or ascending, 5 to 6 lines long, in fruit becoming ovoid and 5 to 9 lines long; nutlets flattened, 1 line broad.

The White Alder borders rivers and perennial streams in the Coast Ranges, Sacramento and San Joaquin valleys and in the Sierra Nevada, in the mountains usually forming continuous files of trees along water-courses. Northward it ranges to the eastern slopes of the Cascades of Washington and to northern

Idaho. In the Coast Ranges it is found everywhere except in the narrow coast strip occupied by the Red Alder. In the Sierra Nevada it is abundant along streams in cañons where in the winter season it is a conspicuous feature on account of the leafless branches heavy with hanging catkins. For about two weeks in February the alternating cañon winds carry the pollen out of the trees up and down the narrow clefts of the mountains like a fog—so great is its abundance. In southern California it is the only alder, and has its southernmost home in the Cuyamaca Mountains.

Altitudinally no other alder and few other species have so great a range. In middle California it is common as low as one hundred feet or even only ten feet above sea-level, ascending in the northern Sierra Nevada to 2500 feet altitude and in the southern Sierra Nevada to 6500 and 8000 feet altitude.

The wood is light, brittle, close-grained and takes a satiny finish; the heartwood is brownish and the sap-wood white but soon turning brownish. It has scarcely been employed as yet for any fine purposes although used to a very limited extent in the manufacture of ladies' glove boxes. The roots, even at the present day, are used by the remnants of native tribes as twining material in the manufacture of baskets.

The diameter growth of White Alder is slower than that of the Red Alder, although it reaches its adult height about the same time, namely, twenty-five to fifty years. The trunks are very long, slender and straight, hold their girth upward very well, and, as in the North Coast Ranges, often clear of branches for forty to sixty feet. Such trees, eighty to one hundred feet high, are often seen. They are valued by the mountaineers for special purposes in construction of farm buildings, such as studs and rafters, but the wood cannot be used where it comes in contact with soil, for it rots quickly. The trunks also furnish admirable material for log-cabins although but rarely employed for this purpose. I remember such a one, well finished, attractive in design and with the logs cleverly joined at the corners, standing in a lonely Sierra cañon, as far as one may comfortably ride in a day from the forks of the Kaweah.

The quality of the wood is such that the logs are not adapted for lumber. If they be sawn into planks the lumber checks and warps so badly as to be of no use. Economic features of the White Alder have been little studied, but in the long run the value of the wood will probably prove to be of far less importance than the relation of this species to water conservation. In all of the more arid parts of the State the lines of trees in cañons are of great value as a stream-cover since they are a distinct factor in the reduction of evaporation. They are never found on living streams that are not permanent, and are to the traveler a more reliable sign of the presence of water than Sycamore or even Cottonwood, although of far less practical value than Cottonwood because not occurring in as arid or in strictly desert country.

The White Alder probably grows to greatest size in the deep, well-watered cañons of the North Coast Ranges. In Mill Creek Cañon near Ukiah are trees ninety to one hundred and fifteen feet high, the finest and tallest that I know. Wherever it grows, the charm of mountain cañons is strikingly enhanced by its long slender white trunks and airy crowns.

### 2. **Alnus rubra** Bong.

RED, OR OREGON, ALDER.

Plate 58, figs. 1-4; plate 59.

ALNUS RUBRA Bongard, Veg. Sitcha, p. 162 (1833); Kellogg, For. Trees Cal., p. 100 (1882); Watson, in Bot. Cal., vol. 2, p. 80 (1880); Parry, Bull. Cal. Acad., vol. 2, p. 351 (1887).

*Alnus oregona* Nuttall, Sylva, vol. 1, p. 28, pl. 9 (1842); Cooper, Pac. R. Rep., vol. 12, pt. 2, p. 28, 68 (1860); Sargent, Silva N. Am., vol. 9, p. 73, t. 454 (1896); Jepson, Fl. W. Mid. Cal., p. 139 (1901); Sheldon, For. Wealth Ore., p. 23 (1904).

Tree commonly 40 to 90 feet high, usually with very white or white-mottled bark; trunk unbranched for 20 to 60 feet and 1 to 2⅔ feet in diameter; leaves 2 to 6 inches long, elliptic-ovate, often rusty beneath, with coarse teeth which are again finely toothed, the entire margin with a narrow underturned edge; staminate catkins stoutish, 3 to 7 inches long; calyx with 4 stamens, but sometimes with 3, especially at upper end of catkin; pistillate catkins 4 to 6 lines long, maturing into oblong-ovoid cones ¾ to 1⅛ inches long; nutlets flattened, acutely margined or some narrowly winged, roundish, 1 to 1½ lines broad.

The Red, or Oregon, Alder fringes streams in deep, cool cañons, spreads out over moist or humid areas in valleys and is distributed from the Santa Inez Mountains northward to southeastern Alaska. It is dependent upon a high annual rainfall and rainy or foggy summers and distinctly favors the neighborhood of the coast. South of San Francisco Bay it is confined to a narrow strip a few miles broad bordering the ocean. Northward it ranges into the interior twenty or thirty miles, for it is found at Ashland, Oregon. Its latitudinal range in California is likewise limited: often abundant but a few feet above sea-level, there are, indeed, trees whose roots are lapped by the ocean tide as on the western shores of Tomales Bay; in the mountains it probably does not ascend higher than 1500 to 2000 feet. According to Sargent it reaches its greatest size in the region of Puget Sound. In California it is especially abundant in Marin, Mendocino, and Humboldt counties, where it forms pure groves of great beauty in marshy or bottom lands near the sea.

The bark is thin, red when cut. The wood is soft, brittle, and coarse-grained; the trunks when cut bleed a reddish sap which defines rather well the annual rings. The growth of the tree is rapid in youth, especially during the first ten or fifteen years. The wood is valued for household fuel and in the north

for smoking salmon. In Oregon and Washington it is used for the manufacture of furniture and in cabinet work, but it is claimed that the California wood is extremely liable to attack by borers. Dr. Kellogg wrote in 1882 that it is exceedingly durable under water and is used for piles, bridge foundations, fish barrels, and boats. It is also made into brake blocks.

The species was first described from specimens gathered by the Russian collector, Dr. Mertens, at Sitka in 1827. Nuttall collected his specimens at the mouth of the Willamette in Oregon.

3. **Alnus tenuifolia** Nutt. Mountain Alder. Small tree or shrub 8 to 14 feet high; leaves roundish to ovate, thickish, at base truncately rounded (or even subcordate) to cuneate, coarsely toothed and again finely serrate, 1 to 3 inches long; staminate catkins 3 or 4 in a cluster, 3 inches long; stamens 2 to 4, not exceeding the 4 sepals; pistillate catkins 3 to 8 in a cluster, sessile or with peduncles almost 2 lines long; cones small, 3 to 7 lines long.

The Mountain Alder forms thickets on wet hillsides or in moist hollows at 5000 to 7000 feet altitude in the Sierra Nevada from Donner Pass northward to Mt. Shasta, thence westward to Trinity Summit and the Siskiyous. It has a wide distribution over western America.

4. **Alnus viridis** DC. var. **sinuata** Regel. Thin-leaved Alder. Slender shrub 6 to 10 feet high; leaves thin, gummy when young, bright green, sharply or laciniately toothed; catkins appearing in spring at the same time as the leaves, the peduncles of the pistillate leafy at least at base, their branches ½ to 1 inch long; sepals 6; stamens 6 or 7.

Subalpine in northern California, occurring on Trinity Summit and Mt. Shasta, at about 6500 to 7000 feet, thence ranging far northward. (*A. sinuata* Rydberg, Bull. Torr. Club, vol. 24, p. 190.)

## 2. Betula L. Birch.

Staminate catkins 1 to 3 in a cluster, sessile or short-peduncled; calyx 4 (or 2)-lobed; stamens 2, each filament with 2 distinct anther-cells. Pistillate catkins solitary on the peduncle and erect, each scale consisting of the bract and 2 bractlets united; scales falling away from the axis when the fruit is mature. Nutlet seed-like, with a broad thin wing.—Nine species in North America. *B. papyrifera,* the celebrated Canoe Birch of our northern regions, does not come nearer our boundary than northern Washington.

### Key to the Species.

Leaves 1 to 2 inches long; lobes of bracts broad, usually parallel, acutish.....1. *B. occidentalis.*
Leaves ½ to 1 inch long; lobes of bracts narrow, divergent, obtusish.....2. *B. glandulosa.*

### 1. **Betula occidentalis** Hook.

WATER BIRCH.

BETULA OCCIDENTALIS Hooker, Fl. Bor. Am., vol. 2, p. 155 (1853); Nuttall, Sylva, vol. 1, p. 22, t. 7 (1842); Watson, in Bot. Cal., vol. 2, p. 79 (1880); Sargent, Silva N. Am., vol. 9, p. 65, t. 453 (1896); Winkler, Engler's Pflanzenreich, vol. 4, pt. 61, p. 86 (1904).

*Betula fontanalis* Sargent, Bot. Gaz., vol. 31, p. 239 (1901).

*Betula alba,* forma *occidentalis* Fernald, Am. Jour. Sci., ser. 4, vol. 14, p. 173, t. 5, f. 3 (1902).

Slender tree 10 to 25 feet high, with red-brown smooth bark and warty twigs; leaves round ovate, sharply serrate, mostly acute at apex, almost or quite glabrous and 1 to 2 inches long; petioles 4 or 5 lines long; staminate catkins 2 to 2½ inches long; pistillate catkins 1½ inches long in fruit and 3 or 4 lines in diameter; nutlets 1 to 1½ lines broad.

The Water Birch grows along streams in cañons of the Sierra Nevada Mountains from Bubbs Creek (8000 feet) northward to Mt. Shasta (2500 to 5000 feet), thence westward to the South Fork of the Salmon and to Humboldt County. It is common along water-courses on the eastern slope of the Sierra Nevada in the Owens Valley region where the poles are used for fencing. It is also called Red Birch and Black Birch.

The relation of our Water Birch to northern and to Rocky Mountain forms is discussed by Sargent (Botanical Gazette, vol. 31, p. 239), who separates the Californian form as *Betula fontanalis;* by Fernald (Am. Jour. Sci., ser. 4, vol. 14, p. 173), who calls it *Betula alba* forma *occidentalis;* and by Winkler (Engler's Pflanzenreich, vol. 4, pt. 61, pp. 84, 85), who considers it *Betula occidentalis* Hooker.

2. **Betula glandulosa** Michx. SCRUB BIRCH. Shrub 1 to 4 feet high with glandular-warty twigs; leaves roundish, serrate, ½ to 1 inch long; pistillate catkins 4 to 9 lines long; nutlet 1 line broad.

High mountains of northern Sierra Nevada (Bridge Creek, Lassen Co.), Warner Range (Modoc Co.), and northward to subarctic regions where it covers vast tracts of country.

## CUPULIFERAE. Oak Family.

Trees or shrubs with alternate simple leaves and promptly deciduous stipules. Flowers monoecious, apetalous, appearing with the leaves in the deciduous kinds. Staminate flowers in catkins; calyx parted into several lobes; stamens 4 to 12. Pistillate flowers 1 to 3 in an involucre of imbricated scales, the involucres solitary, borne in reduced or short catkins, or at the base of staminate catkins; ovary adherent to the calyx, 3-celled, 6-ovuled, only one ovule maturing, the remaining ovules and the other two cells abortive. Fruit a nut borne singly in a scaly cup, or 1 to 3 in a spiny bur.

### Key to the Genera.

Fruit an acorn; catkins simple.
- Catkins unisexual, the staminate drooping ..... 1. Quercus.
- Catkins erect, all with staminate flowers, pistillate flowers at base of some of them ..... 2. Pasania.

Fruit a spiny bur; catkins erect, often branching, unisexual or with pistillate flowers at base of some of the staminate ..... 3. Castanopsis.

### 1. Quercus L. Oak.

Trees or shrubs of slow growth, hard wood and usually contorted branches. Flowers greenish or yellowish. Staminate catkins pendulous, one or several from the lowest axils of the season's shoots. Pistillate flower 1 in an involucre; involucres 1 or 2, rarely several, borne in the upper axils of the season's shoot sessile, less commonly pedunculate, or when several sometimes scattered on a short catkin-like spike; ovary with 3 to 5 styles or stigmas. Fruit an acorn, the nut set in a scaly cup. Abortive ovules often discernible in the ripe or nearly ripe acorn.—About three hundred species distributed over the northern hemisphere. California has fourteen species, nine trees and five shrubs; it is for its area strong in species but very weak in individuals. Washington has one and Oregon five species, all of which occur in California.

#### Key to the Species.

White Oaks.—Bark commonly white or whitish, wood light-colored; stamens mostly 6 to 9; stigmas sessile or nearly so; abortive ovules mostly towards base of nut.

Acorns maturing the first year; nut glabrous on the inner surface.

Deciduous species.

Branchlets pendulous; acorn cups deep, the nut long and slender; leaves pinnately parted with coarsely 2 to 3-toothed lobes; trunk bark dark brown, deeply cuboid checked; valleys ..... 1. *Q. lobata.*

Branchlets not pendulous; acorn cups shallow; trunk bark white, shallowly checked but smoothish.

Leaves dark lustrous green above, rusty or pale beneath, 5 to 7-parted; nut subglobose, or oblong-cylindric.

Mossy trees; mainly North Coast Ranges ..... 2. *Q. Garryana.*

Shrub; montane ..... Var. *Breweri.*

Leaves bluish green above, pale beneath, oblong, coarsely toothed or entire; nut oval, often swollen at or below middle; dry foothills ..... 3. *Q. Douglasii.*

Evergreen species.

Small tree; leaves blue-green, oblong, mainly entire, nut subcylindric; southern California ..... 4. *Q. Engelmannii.*

Shrubs; cups saucer-shaped.

Branches rigid; leaves ¾ to 1 inch long; chaparral areas.

Leaves brittle, plane or somewhat undulate margined, usually light green, oblong, spiny-dentate or entire; nuts oval to cylindric, blunt or pointed ..... 5. *Q. dumosa.*

Leaves tougher, dark green, convex above, regularly dentate; nuts short cylindric or subglobose, very obtuse ..... 6. *Q. durata.*

Branches slender, pliable; leaves 2 to 4 inches long, strongly parallel-ribbed, toothed, chestnut-like; local in Siskiyous and vicinity ..... 7. *Q. Sadleriana.*

Acorns maturing the second year; nut tomentose or hairy on the inner surface.

Trees; acorn cup usually very large and thick.

Leaves 2 to 3½ inches long, densely woolly when young, with prominent regular parallel nerves; islands off south coast ..... 8. *Q. tomentella.*

Leaves commonly 1 to 2 inches long, entire or spinose-toothed, dull green above, lead-color beneath or with a golden fuzz when young; cup typically like a yellow turban; mountains ..... 9. *Q. chrysolepis.*

Shrubs; acorn cup sub-turbinate or low bowl-shaped, thin; leaves ½ to 1½ inches long.

Branches slender and pliable, forming broom-like tufts at top of stems; leaves mostly entire, no golden fuzz ..... 10. *Q. vaccinifolia.*

Branches rigid, spreading; leaves dentate-prickly, olivaceous above, pale beneath; Southern and Lower California ..... 11. *Q. Palmeri.*

Black Oaks.—Bark dark or black, wood dark or reddish; stamens mostly 4 to 6; stigmas on long styles; abortive ovules mostly towards top of fruit; nut tomentose within.

Acorns maturing the first year, nut slender ovate; leaves roundish or elliptic, convex above; coast valleys and hills ..... 12. *Q. agrifolia.*

Acorns maturing the second year.

Leaves oblong, obtuse or tapering to the acute apex, plane, pale yellowish below; nut slender ovate, often streaked longitudinally; interior valleys and hills ..... 13. *Q. Wislizenii.*

Leaves pinnately parted, the divisions generally coarsely toothed, always bristle-tipped; nut oblong, obtuse; mountains ..... 14. *Q. Kelloggii.*

## 1. Quercus lobata Neé.

### Valley Oak.

Plate 60, figs. 1-4; plates 1, 14, 61-66.

Quercus lobata Neé, An. Cienc. Nat., vol. 3, p. 277 (1801); Bolander, Proc. Cal. Acad., vol. 3, p. 230 (1866); Torrey, Bot. Wilkes Exped., p. 461, pl. 15 (1874); Engelmann, in Bot. Cal., vol. 2, p. 95 (1880); Kellogg, For. Trees Cal., p. 54 (1882); Powers, Proc. Cal. Acad., vol. 5, p. 374 (1874); Greene, West. Am. Oaks, p. 13, pl. 8 (1889), Erythea, vol. 2, p. 64 (1894); Sargent, Gard. and For., vol. 3, pp. 606, 611, ill. (1890), Silva N. Am., vol. 8, p. 23, t. 362 (1895); Coville, Bot. Death Val. Exped., p. 197 (1893), Shinn, Gard. & For., vol. 10, p. 52, fig. 8 (1897); Purdy, Gard. & For., vol. 10, p. 202, figs. 25, 26 (1897); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 518 (1900); Jepson, Erythea, vol. 7, p. 131 (1899), Fl. W. Mid., Cal., p. 142 (1901). Forma argillora Jepson, Fl. Cal., pt. 2, p. 353 (1909). Forma insperata Jepson, l.c. Var. turbinata Jepson, l.c., p. 354. Var. Walteri Jepson, l.c., p. 353, fig. 64.

*Quercus Hindsii* Bentham, Bot. Sulphur, p. 55 (1844); Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 138 (1856); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 29, pl. 1, fig. 7 (1857).

"Oak with long slender acorn," Fremont, Rep. Second Exped., p. 241, 242 (1845).

Graceful tree, commonly 40 to 75 but not rarely 100 feet tall, with a great crown which, in typical form, is broader than high, and whose spreading limbs finally end in long and slender pendulous branchlets reaching nearly or quite to the ground; trunk 2 to 8 or even 10 feet in diameter and 10 to 30 feet in height before parting into the main arms of the crown; bark on the main trunk 1 to 4½ inches thick, dark brown or sometimes ashen gray, and checked nearly to the wood into plates 1 or 2 inches across; plates on typical trunks cuboid but often rectangular or narrow; leaves 3 to 4 (rarely 6) inches long, 2 to 3 inches broad, green above, paler beneath with a thin but close covering of short hairs, yellow-veined, parted to the middle or nearly to the midrib into 3 to 5 pairs of lobes; lobes most commonly broadened towards the end, less frequently pointed, coarsely 2 or 3-toothed at apex, or sometimes entire; leaves of the sterile pendulous shoots smaller and more deeply lobed than the ordinary leaves; staminate catkins 1 to 3 inches long; calyx-lobes 6 to 8, linear; stamens 8 to 11; pistillate flowers mostly solitary and sessile, producing acorns which mature in the first autumn; cup drab-brown, with a dull reddish tint, deeply hemispherical and very warty or tuberculate, ½ to ¾ inch deep or more, and of greater diameter than the nut; nut long conical, at first bright green, later mahogany or chestnut-brown, 1½ to 2¼ inches long and ½ to ¾ inch in diameter.

The Valley Oak, known also as California White Oak or as Weeping Oak from its graceful drooping sprays, and called Roble by the Spanish-Californians, is distributed from the Trinity River and Shasta County southward to Fort Tejon, Saugus, Santa Barbara, and the Ojai Valley, a few stragglers ranging to the San Fernando Plains, and as far as Santa Monica. It is, therefore, strictly Californian and all but confined to the Sacramento and San Joaquin valleys and the valleys of the Sierra foothills and Coast Ranges, where

on the richest land it is most abundant and occurs in typical form. While all trees on the fertile loams are not weeping, weeping trees are almost absolutely associated with the fertile loams. The drooping sprays, which characterize the trees in such situations, are very slender, the size of a pencil or less, leafy, and as much as ten to twenty feet in length. On vigorous individuals they are produced in sufficient abundance to give character to the tree, but where trees crowd ever so little they are not developed on the contiguous sides of the crown. As a result of this drapery of foliage a tall tree stands in a great soil area which is protected in the dry season from excessive desiccation by a sun which shines six months from a cloudless sky. (Plate 14.)

The Valley Oak favors both moist soil and hot valleys. While it does occur in the valleys near the sea when protected by a range of hills, it shows a strong dislike for valleys facing the ocean and is not found on the Humboldt coast, on the flats of Point Arena, in Olema Valley, in the valley of San Francisco Bay facing the Golden Gate, nor in the Santa Cruz Valley. Moreover it reaches its best development only in hot, dry valleys beyond the immediate influence of the ocean. Altitudinally it occurs chiefly between 10 and 1400 feet above sea-level, but ranges into foothill valleys sometimes as high as 2700 feet in the northern half of its area and to 4500 feet at the south.

In its life-history it exhibits four marked stages: The pole stage, the elm stage, the weeping stage and second youth. The forms typical of each of these stages may be described as follows. Pole stage: Young trees ten to twenty feet high grow strictly erect, pole-like, even in the open, and usually have short spreading lower branches, tapering to slender tops. Elm stage: Trees thirty to sixty years old and thirty to forty-five feet high are of the elm type, with a vase-shaped crown of compactly ascending branches, and with the trunk clothed over half-way down to the ground with short, recurved or drooping branches which originate from base of crown. The whole tree is, sometimes, very twiggy and therefore very leafy, strikingly so on main branches and trunk, and commonly without pendulous branchlets. Weeping stage: Trees one hundred and twenty-five to three hundred years of age are mature, fifty to one hundred feet high, and show a broad crown of tortuous branches and weeping sprays. Second youth: Old trees whose branches have been lost by storm or disease, often show a new crown or straightish-erect or ascending branches, although as frequently becoming irregular in outline or broken-topped. The "elm stage" is illustrated in plate 63, the "weeping stage" in plate 61, and "second youth" in plate 14, which also exhibits the pendulous cords. The straight-limbed white-barked tree of the clay lands of the San Antonio River valley is illustrated in plate 1.

Trees of remarkable height, span of crown, or diameter of trunk are rather numerous and often have more than a local reputation. The most famous one

is the great tree on the General Bidwell Ranch at Chico, which was named the Hooker Oak in honor of Sir Joseph Hooker, long time Director of the Royal Gardens at Kew, England, who in company with Asa Gray visited the tree in 1877. It is in every way a fine representative of its race. The largest tree, considering all dimensions, is the Henley Oak in Round Valley. It is one hundred and fifty feet in height and nearly twenty-five feet in trunk circumference at four feet above the ground. There is a notable tree between Kelseyville and the Indian Mission. The great oak of Big Oak Flat, destroyed by the miners in early days, was of this species and said to be eleven feet in diameter. At the lower end of Scott Valley near the Blue Lakes Road is a tree with a height of one hundred and twenty-five feet and a trunk forty-five feet high before branching into the narrow crown. At five feet above the ground the trunk is three feet eight inches in diameter. It was measured in 1897 and is shown in plate 64. The bark is of a different character from the ordinary *Quercus lobata* bark and is shown in plate 65. Many other trees of this type at one time grew in the neighborhood and in the lower part of Bachelor Valley, and were undoubtedly crowded when young, thus pushing the survivors up to this exceptional height. Other trees which have been measured find a place in the following tabulation:

INDIVIDUAL VALLEY OAK TREES.

| Location of Trees. | Height in feet. | Diameter of Trunk at — ft. above ground. | Span of Crown. |
|---|---|---|---|
| "Olney Oak," on the Olney Ranch, near San Ramon Valley. | | 6⅙ ft. at 3½ ft., 8⅙ ft. at ground. | Longest diameter, 109 ft. 1 in.; shortest, 93 ft. 3 in. |
| Suisun Valley, 1 mile west and northwest of Manka's Corners. | 75 | 5¼ ft. at 4 ft. | |
| Upper Ojai Valley. | 130 | 6½ ft. at ground. | 120 ft. |
| Round Valley, upper end. | 90 | 7 ft. at 5 ft. | |
| Potter Valley, near Hahn's Ranch on county road. | | 7 ft. 10 in. at 5½ ft. | |
| Willits, south side of town. | 100 | 7 ft. 4 in. at 5 ft. | |
| Eshom Valley, north end. | 110 | 7 ft. 8 in. at 4 ft. | |
| Eshom Valley, south end. | 70 | 9 ft. 5 in. at 7 ft., 11½ ft. at ground. | |
| Priest Valley, north fork of Lewis Creek. | 85 | 8 ft. 5 in. at 5 ft., 11 ft. 1 in. at ground. | |

It will be noted that the very largest trees are not restricted to any single region, but occur in every locality throughout the main range.

The great size attained by these oaks is readily accounted for. They inhabit the most fertile loams and live in situations where the water-table is only twenty to forty feet, or frequently but ten feet, below the surface. In the valley

region the annual rainfall varies from ten to thirty-five inches throughout their range, while the temperature rarely falls below 32° F. and then only for short periods during the night. Their growth is rapid. Furthermore, the largest individuals, as well as the largest groves are characteristic of, although not peculiar to, delta lands or half-drained valleys. Such areas are subject to overflow in the winter with the rains, or in the spring with the "spring-rise" from melting snow in the mountains.

With such conditions for tree growth it is not surprising that the age of even the largest trees is not remarkable. "In the delta of the Kaweah River, formerly known as the Four Creeks Country, there are about four hundred square miles of Valley Oaks," writes George W. Stewart, of the U. S. Land Office in Visalia, who made for this volume the count of rings given in the table below. "About the last forty rings appeared to be narrower in all the trees measured than those nearer the center and were of more uniform width. Perhaps this is due to the settlement of the country fifty years ago, the diversion of the water from its natural channels for irrigation and the consequent deprival of the trees of the amount of water they had been accustomed to."

Age Table of Valley Oak Trees.

| No. | Diameter of wood. | Rings in wood | Thickness of bark. | No. | Diameter of wood. | Rings in wood. | Thickness of bark. |
|---|---|---|---|---|---|---|---|
| 1. | 21½ inches | 185 | 1½ inches | 6. | 36 inches | 219 | |
| 2. | 32 inches | 190 | 2 inches | 7. | 38½ inches | 221 | |
| 3. | 30 inches | 180 | 2 inches | 8. | 27 inches | 131 | 1½ inches |
| 4. | 46 inches | 243 | 2 inches | 9. | 51 inches | 234 | 1½ inches |
| 5. | 32 inches | 184 | 1¾ inches | 10. | 62 inches | 294 | 2 inches |

The measurement of No. 1 was on a cut about 10 feet from the ground. Numbers 6 and 7 were twin trunks from a single stump. Number 4 was hollow for about 5½ or 6 inches at the heart. Number 9 had a hollow at the center 5 inches wide, but 23 inches of solid wood revealed 234 rings. In number 10 the trunk measured 29 inches from center to circumference along the radius where the count was made, but of this, 2 inches at the heart were missing through decay. Since the cut in this stump was made at eighteen inches above the ground, it is then clear that the total age covers a period of something over three hundred years. From the above and other measurements it may confidently be stated that the adult trees of the Valley Oak are from 125 to 310 years of age. It is possible that five hundred years may have passed since the seeding stage of those great trees whose trunks are now eight feet in diameter.

Both longitudinally and altitudinally *Quercus lobata* selects areas remarkably uniform in physical conditions. As might then be expected, it is subject to

slight variation and is, indeed, the least variable of West American oaks, especially in habit, character of foliage, bark and acorn-cups. The nuts are commonly typical, but specimens slender as a pencil, slender conical, or short and thick may be taken from one grove. I have studied groves in which each tree had its own type of nut, yet none could be mistaken as belonging to any other oak for the variation is within certain well defined limits.

The following forms may be noted:

Forma **argillora** Jepson. Trees mostly or quite destitute of pendulous branchlets; bark smoother, often whitish and simulating Blue Oak trunks; leaves usually very deeply and narrowly lobed, often persistent through the winter.—Clay hills, as on the Araquipa Hills, Solano County.

Forma **insperata** Jepson. Leaves narrow, ¾ to 1¼ inches broad, 1½ to 2¼ inches long; cups strongly tuberculate, not so deep as in the typical form; nuts rather shorter than usual, 1¼ to 1⅝ inches long.—Kaweah River Basin, 3500 feet.

Var. **turbinata** Jepson. Tall typical trees with larger, mostly deeply lobed leaves and more open sinuses than in the type; nuts inversely top-shaped and set in shallow cups with scales not so strongly tuberculate.—Little Lake Valley.

Var. **Walteri** Jepson. Leaves 3 to 4 inches long, nearly as broad, sharply but mostly shallowly sinuate; cup large (1 inch broad) but shallow; nuts thick-ovate, obtuse 1½ inches long, 1 to 1⅛ inches thick.—Kaweah River Basin, 4600 feet.

Reproduction is almost exclusively by seed, only young trees sending up stump sprouts when cut down. Seedlings come up freely in protected situations, especially where there is some disturbance of the surface soil. Adult trees do not stump-sprout and when once cut down their life-history is ended. The removal of oak trees from valley land is usually to make place for fruit trees, but the horticulturist generally finds that the fruit tree set in the place of the Valley Oak does not thrive or grows for a time and then dies. He says the soil is poisoned by the oak's roots. In a sense this is true. The fungi parasitic on the oak evidently attack the roots of the fruit tree, with frequently fatal results to the latter.[41] In some other cases reluctant growth may be due to other causes, as for example, the unpreparedness of the soil. The oak sends down vertical and very strong roots branching far and wide through the soil which, therefore, undergoes much compression and semi-lithification, so that it is, to a very large extent, rendered inert by lack of chemical action from air and water which ordinary soil receives.

[41] Smith, Univ. Calif. Agr. Exp. Sta. Bull. no. 203, p. 58 (1909).

This species bears more abundant crops of acorns than any other West American oak. They are the most handsome and trim, and the largest of any western species. On account of their plentifulness and sweetness, Valley Oak was one of the very important food trees of the native tribes who ground the kernels into flour for soup and bread.

The tree is well protected against fire by its thick bark. Surface or grass fires are not serious until one side of the trunk is injured through the burning of accumulated dead twigs or branches, and the flames begin to eat out heart-wood. Richard Brinsley Hinds, of the British Exploring Ship *Sulphur,* records in 1837 that the Indians along the Rio Sacramento "have a very pernicious habit of lighting their fires at the bases [of the valley oaks]; and as they naturally select the largest, it was really a sorrowful sight to behold numbers of the finest trees thus prematurely and wantonly destroyed."

The native grape (*Vitis californica*) is often an enemy of individuals standing on stream banks. Climbing to the top of the tree, it sends its runners to the end of every branch and then proceeds to shroud the tree in a drapery of leaves, forming columns of foliage fifty to eighty feet high. Cut off from sunlight the tree dies, eventually rots off and collapses, carrying down the grape in its fall. (Plate 66.)

The wood of the Valley Oak is white, hard, brittle and is not esteemed for constructive purposes or manufacturing, being the least valuable hard wood on the Pacific Coast. The first settlers among the great groves of the San Joaquin and Sacramento made log cabins from the oaks and also split them into "shakes," posts and rails, but they valued the wood little except as fuel, for which it is still extensively used. A single tree often yields fifty to ninety cords of stovewood.[42] So frequently an inhabitant of the delta lands, it is called "Water Oak," "Bottom Oak," and "Swamp Oak," while the folk-name "Mush Oak" carries with it a species of contempt and tells a long story of its failure to meet the requirements of a tough, strong wood in a land where good oak is scarce and dear.

Specimens of *Quercus lobata* were first collected in the Monterey region in 1792 by Señors Robredo and Esquerra, Spanish naval officers of the Malaspina Expedition, and not by Luis Neé, as commonly said, who did not visit California. Vancouver, Fremont, Newberry, and other early explorers admired the graceful beauty of the tree and pay it high tribute in their narratives. Although but slightly appreciated by Californians no other tree is so characteristic of the lower altitudes, none other speaks so much for the fertility of the soil, and none other approaches it in its unexampled park-like effect on the valley floors.

[42] A "stovewood cord" is variable quantity in different parts of California, but it usually means a cord eight feet long and four feet high, consisting of two tiers of 14-inch or 16-inch sticks.

## 2. **Quercus Garryana** Dougl.

### Oregon Oak.

Plate 67, figs. 1-4.

Quercus Garryana Hooker, Fl. Bor. Am., vol. 2, p. 159 (1853); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 28, 68 (1860); Nuttall, Sylva, vol. 1, p. 14, pl. 1 (1865); Bolander, Proc. Cal. Acad., vol. 3, p. 229 (1866); Engelmann, in Bot. Cal., vol. 2, p. 95 (1880); Kellogg, For. Trees Cal., p. 72 (1882); Greene, West Am. Oaks, p. 11, pl. 7—the acorn poor—(1889); Sargent, Silva N. Am., vol. 8, p. 29, t. 364, 365 (1895); Jepson, Fl. W. Mid. Cal., p. 142 (1901).

Var. Breweri Jepson, Fl. Cal., pt. 2, p. 354 (1909). *Quercus Breweri* Engelmann in Bot. Cal., vol. 2, p. 96 (1880); Sargent, Silva N. Am., vol. 8, p. 27 (1895), in part. *Quercus lobata* var. *Breweri* Wienzig, Jahrb. Bot. Gart. Berlin, vol. 3, p. 188 (1885).

Var. semota Jepson, Fl. Cal., pt. 2, p. 354 (1909).

*Quercus Douglasii* Bentham, Pl. Hartw., p. 337 (1857), not of Hook. & Arn.!

*Quercus Oerstediana* Greene, West Am. Oaks, p. 19, pl. 10 (1889).

Tree commonly 25 to 55 feet high, the trunk 1½ to 5 feet in diameter and dividing into wide-spreading limbs which support a broad rounded crown 30 to 60 feet in diameter; trunk bark white, thin (½ inch thick), smoothish, but on typical trunks superficially fissured into longitudinal bands which are transversely checked into small squarish scales 1 inch or less in diameter; leaves 3 to 4 or 6 inches long, 1½ to 3 or 4½ inches broad, dark lustrous green and subglabrous on the upper surface, rusty or pale, finely pubescent and yellow-veined beneath, leathery in texture and parted into 5 to 7, or rarely 9, lobes with mostly deep and often acute sinuses; lobes entire or with 2 or 3 coarse rounded unequal teeth, even on the same leaf; staminate catkins hirsute; stamens 4 to 6; pistillate flowers sessile or short-pedunculate; acorns maturing in first autumn; cup very shallow, 6 to 9 lines broad, with tuberculate scales; nut bulging beyond the small cup, typically subglobose but varying to obovoid or subcylindric, although always rounded at apex, ¾ to 1¼ inches long, ⅔ to 1 inch thick, its surface polished and shining.

The Oregon Oak inhabits mountain ranges near the coast from the Santa Cruz Mountains, where it is rare, northward to Washington and British Columbia, where it is the only oak. It is abundant and the most common oak on the highest slopes and ridges of the North Coast Ranges at a distance of twenty to forty miles from the ocean in a region inside the Redwood Belt known as the "Bald Hills" of Mendocino and Humboldt counties. It grows, too, on the mountain slopes on both sides of the Ukiah, Russian River and Santa Rosa valleys, but does not, so far as known, cross the Mt. St. Helena Range into southern Lake County, nor the Mt. Hood Range (south of Mt. St. Helena) into eastern Napa County, although in the dusty summer season a tree might be passed by for a Blue Oak or a Valley Oak unless one went warily. The Blue Oak, however, is in this region a tree of lower altitudes and in any event trespasses but

little upon the area of the Oregon Oak. Blue Oak and Oregon Oak are found together in the hills near Santa Rosa and so on in the same hills as far as Ukiah on both sides of the valley, but a little farther as one climbs the great ridges northward and comes into the high provinces of the Oregon Oak the former tree is no longer seen.

Notwithstanding the synonymy, *Quercus Garryana* is not an especially variable species and is, indeed, in most particulars less variable than any other Californian oak except *Quercus lobata* and *Q. Kelloggii.* In the Coast Ranges there are two arboreous forms vaguely characterized by their foliage. In one the leaf is leathery, dark green and varnished above, light green beneath, the lobes pointing upwards, entire, often inclined to be triangular with the upper side less curved and more nearly horizontal than the lower side; sinuses open. In the other the leaf is often thinnish, lighter green above and dull, lobes irregularly quadrangular in outline with two or three coarse, rounded, unequal teeth (Pl. 67, fig. 1); this type is more nearly like the ordinary broad-leaved form of the Valley Oak. The two forms merge into each other and are found in the same districts, growing in the mountains between 1000 and 4000 feet. The first type is, for example, represented by specimens from Willits, no. 2406 and Trinity Summit, no. 2060. The second type is represented by specimens from Walker Valley, no. 2190, Willits, no. 1825 (thickish leaved). Intermediate states are nos. 2418 (Ukiah) and 2085 (Summerville, Siskiyou County). These states are really of little significance but have been made the basis of distinctions for presumed species. All the above numbers were collected by the writer.

In connection with these mere leaf forms, descriptions of certain shrub forms may here appropriately find place, as follows:

Var. **Breweri** Jepson. Brewer Oak. (Plate 67, fig. 5.) Spreading shrub 4 to 18 feet high; leaves pinnately parted to middle, the lobes entire and acute, or broad and again lobed, finely pubescent or at length subglabrous, sometimes nearly felt-like below, often lustrous green above, smaller than the type; cup shallow, 7 to 10 lines broad, the scales tuberculate; nut oval, $\frac{3}{4}$ to $1\frac{3}{8}$ inches long.

High montane in the North Coast Ranges from the Scott Mountains westward to Marble Mountain and the Klamath Range, and south to the Trinity Mountains. It was first collected in August, 1862, by W. H. Brewer, at that time botanist of the California State Geological Survey. Brewer Oak occurs also in the Yollo Bolly range in the same or in modified form where it is characteristic of the highest ridges and peaks up to 7000 feet. It is there gregarious, covers hundreds of acres, and is a browse shrub of economic importance, since cattle not only live but fatten upon its leaves and acorns. The

protein content of the leaves is, according to the analysis of W. W. Mackie,[43] 14.04 per cent., or almost equal to that of alfalfa hay.

Var. **semota** Jepson. Kaweah Oak. Shrub; leaves pinnatifid, the sinuses rather sharp, 3 to 4 inches long, 1¾ to 2¼ inches broad; cup shallow; nuts oval, 10 to 13 lines long.—Southern Sierra Nevada from Snow Creek in Mariposa County southward to the Kaweah River, forming an important part of chaparral areas on the San Joaquin and Kaweah River basins between 4000 and 7000 feet. In its usual or prevailing form it displays foliage and acorns which show conclusively that it is a shrub form or at most subspecies of the Oregon Oak (*Quercus Garryana*). The latter exhibits in the North Coast Ranges two leaf types, one with the lobes acute, the other with the lobes broad towards apex and shallowly 2-lobed. The leaves of the southern shrub are exactly like the type first described, although occasionally like the leaves of the second type. The southern shrub also bears sterile shoots with leaves suggestive of both the Black Oak and Valley Oak, or this may be a confused and really distinct species.

The tree form of the Oregon Oak is remarkable for the whiteness of its trunk bark, which accounts for the wide use of the folk-name White Oak. The trunks of some of the trees look as if newly white-washed, while those of most of them are very light colored, but the degree of whiteness varies of course with different localities. There is a fine grove far up on Redwood Creek, about forty-five miles above the ford of the Hupa Trail. Towards nightfall the dark crowns blend with the hillside and the white trunks stand up like stones to mark the dead. At Lagunitas, near Mt. Tamalpais, the trunks are dull brown. More constant than the color character is the character of the ribbon-fissured bark. Yet occasionally this species will veer off strangely and produce a tree whose bark is thick and wholly or partly cuboid-broken like that of Valley Oak. Contrariwise the latter will sometimes display Oregon Oak bark.

Old trees of Oregon Oak clear their crowns of dead leaves in the winter, but young trees hold the brown leaves until after the new leaves appear in the spring. The age limits are not known. Stump-sprouting does not occur in the adult trees or but weakly, reproduction being chiefly by means of seed. Acorns are produced in abundance, and the seedlings frequently colonize favorable slopes. On the Bells Spring Ridge in Mendocino County and northward to the Salmon River I have found many colonies of slender straight trees six to twelve feet high standing as thickly as stalks in a cornfield.

*Quercus Garryana* was first discovered on the northwest coast in the latter part of the 18th century by Archibald Menzies. It was re-discovered by the Lewis and Clarke Expedition on the Columbia River in 1806, but not designated as a new species until nearly a quarter of a century later, when specimens

[43] The Value of Oak Leaves as Forage. Univ. Calif. Agr. Exp. Sta. Bull. 150 (1903).

were collected in the same region by David Douglas, who named it in honor of his friend Nicholas Garry of the Hudson Bay Company, from whom he had received many favors while exploring northwest America.

The wood of the Oregon Oak is white, hard, fairly strong, straight and close-grained and works easily when green. The young growth is said to be very tough and strong. In the North Coast Ranges it is called Post Oak and is used in running barb-wire fences by the cattlemen, who find that it splits readily and is durable in contact with soil, lasting fifteen or twenty years if the sapwood be cut off. The wood is remarkably white, takes a good polish, and is converted into furniture and used for interior finish on the coasts of Oregon and Washington, where it is most abundant. It has long been used in ship building. It is, next to the Maul Oak, the most valuable of all West American oaks.

In an unpublished manuscript on this oak by Douglas, preserved in the library of the London Horticultural Society, occurs the following note: "The acorns are greedily sought by bears. By several of the native tribes they are gathered in the months of August and September and deposited in pits on the margins of lakes or streams so that they are completely covered by water, in which state they lie till the following winter, when they are taken out and without any other preparation than simply wiping, they are eaten as an article of food. The smell is disagreeable and, as might be expected, they are far from being of a palatable flavor."

The Oregon Oak in all the higher North Coast Range country is an important element in the woodland scenery and large trees are common. The southern slopes of the Van Arsdale Ranch in southern Mendocino show many fine specimens. They are scattered about or in clumps with clean spaces between, giving a beauty to these hills similar to that which the Valley Oak imparts to the valley levels. One notable tree is eighty feet high; the span of the branches which form its crown is one hundred and twenty-six feet, while its trunk diameter is five feet four inches at three feet six inches from the ground. All the trees thereabouts near the summit of the Walker Valley grade are large and with branches very tortuous and very mossy, as generally in adult trees of this species.

This locality is in the southerly part of the "Bald Hills" of Mendocino and Humboldt, where the Oregon Oak is everywhere an important part of the forest. The "Bald Hills" are not hills, but mountains, and they are bald only on their crowns. They are full of cañons; they are drained by perennial rivers; they rise to a height of 3000 to 6000 feet; their sides are often steep and level land is scarcely to be found. Notwithstanding all this, their outlines are soft and rounded on account of the unresistant materials composing them. The occasional uplifts of splintered rocks but serve as striking guide-marks in traversing this wooded mountain country. Douglas Fir, Tan Oak, Black Oak and Madroña

are associated with Oregon Oak and form extensive groves or small clusters of irregular outlines with grassy deer-parks between, free glades at the heads of wooded cañons, or "opens" here and there on the slopes or very summits. He who is to supplement technical training in landscape work by studies of nature, could not do better than to visit these mountains. There are not woodlands elsewhere in California that for studies of tree-groups and contour and color surpass these.

### 3. **Quercus Douglasii** Hook. & Arn.

BLUE OAK.

Plate 60, figs. 5-8; plates 3, 68.

QUERCUS DOUGLASII Hooker & Arnott, Bot. Beechey, p. 391 (1841); Hooker, Icon., vol. 4, tt. 382, 383 (1841); Nuttall, Sylva, vol. 1, p. 20, t. 4 (1865); Engelmann in Bot. Cal., vol. 2, p. 95 (1880); Kellogg, For. Trees Cal., p. 57 (1882); Greene, West. Am. Oaks, p. 17, pl. 9, f. 1 and 2, pl. 12, f. 4 and 5 (1889); Coville, Bot. Death Val. Exped., p. 196 (1893); Sargent, Silva N. Am., vol. 8, p. 79, t. 386 (1895); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 518 (1900); Jepson, Fl. W. Mid. Cal., p. 142 (1901).

Tree commonly 20 to 60 feet high, typically with a rounded crown and with a trunk ½ to 2 or sometimes 4 feet in diameter; bark white, shallowly checked into small thin plates, only slightly roughened but with the characteristic roughness extending up the limbs well into the branches; leaves minutely pubescent, bluish green above, pale beneath, 1 to 3 inches long, ½ to 2½ inches broad, mostly oblong to obovate, entire, or coarsely and often unequally few-toothed, or shallowly lobed; staminate catkins about 1 inch long; calyx yellow or green, with laciniately cleft segments and about 9 stamens; acorns ripe in first autumn; cup 4 to 6 lines broad, of less diameter than the nut and very shallow, the scales developing small wart-like processes; nut ¾ to 1½ inches long, 6 to 10 lines in diameter, dark or light brown, oval in outline but variable, often much swollen just below or at the middle or only on one side, or again narrow and tapering to apex.

The Blue Oak, sometimes called Rock Oak or Mountain White Oak, is an inhabitant of dry, rocky hills which are excessively arid in the rainless season. It is the first tree met with in entering the Sierra foothills, where it forms a thin but extensive growth between 300 and 1500 feet in the north and 500 to 2500 or even 4000 feet in the south. It is common in the foothills of the Coast Ranges from the inner ranges west of San Joaquin Valley westward to the ocean and from the Sacramento Valley to the foothills of Round, Ukiah and Santa Rosa valleys. Northward it ranges to the foothills of the upper Sacramento and is abundant on the gravelly floor of the Sacramento Valley between Red Bluff and Redding as an associate of the Digger Pine. Southward it extends to the confines of Southern California, the southernmost stations being in the Sierra Liebre

foothills and in San Fernando Valley. It reaches its maximum development in the South Coast Range country from Jolon to Paso Robles and southward. The largest specimens are doubtless found in Monterey County, where there are thousands of trees fifty-five to seventy-five feet high scattered over the valley floor of the San Antonio and Nacimiento rivers.

Throughout its range *Quercus Douglasii* is exceedingly uniform in aspect, hue of foliage, character of bark and in acorn cups. It is somewhat variable in its nuts and is more inconstant in size and outline of its leaves than any other Californian Oak save, perhaps, the Scrub Oak. One may find upon a single individual narrowly oblong to obovate or roundish leaves, either wholly entire, or on the other hand toothed or lobed, the teeth or lobes few and more or less different on either side in size or number, sometimes with rounded teeth, sometimes with sharp teeth, sometimes with both, sometimes again with a single lobe or tooth on one side and none on the other, but the teeth or lobes as a rule notably unequal or irregular. (Plate 68.) On the other hand, one as frequently finds a tree on which a particular type of leaf prevails although the type varies from tree to tree.

Abnormalities in the form of huge, wart-like swellings are sometimes seen on trunks of this species. Sometimes, again, the whole tree or the reproductive parts are abnormally affected. Two freak trees of the Blue Oak have been reported. One has a low, broad, rounded crown, twenty-five feet high and forty feet broad, like a gigantic toadstool, and stands on the Calhoun Ranch, west of Windsor, in the Santa Rosa Valley.[44] The other tree is on the Meader Ranch, Fair Oaks, and produces acorn-cups with singularly enlarged or wart-like scale developments. The causes in both cases are doubtless pathological.

This species affords an example of exclusiveness in those regions where it grows, illustrating the lack of variety in tree growth over wide extents of country characteristic of many parts of California and often remarked by the traveler. One may journey for many miles in certain districts or at certain altitudes and see only the Blue Oak; or again it may have one associate, the Digger Pine. In other places, less severe, as in the Araquipa Hills of Solano County, it is mingled with the Valley Oak, Black Oak and Interior Live Oak. In the Sierra foothills at the higher altitudes the Interior Live Oak is, next to the Digger Pine, its most common associate. The exclusiveness of *Quercus Douglasii* is marked even in well-wooded regions of the Coast Ranges. The lower slopes of Howell Mountain may be cited in illustration. In that locality the trees are low and gnarled, and keep mainly to the dry rocky south slopes, mixing little with the Douglas Fir, Madroña or Live Oak.

[44] Since receiving foliage from this tree, a supply of fruiting material, collected by W. H. Calhoun, has been forwarded. The acorns are nearly those of *Quercus Garryana* Dougl. It seems not improbable that this tree may owe its origin to spontaneous hybridity between *Quercus Douglasii* and *Quercus Garryana*. Cf. "Singular Californian Oaks," in Pacific Rural Press, vol. 57, p. 9 (1909).

So constitutionally adapted to the driest slopes is the Blue Oak that it cannot accommodate itself to an excess of moisture. Irrigating ditches cut too near hillside trees will gradually kill them, although the associated Live Oak (*Quercus Wislizenii*) profits by the increase of water. The Blue Oak is again weak in that it is more subject to dry rot than any other Pacific Coast oak. The wood is brittle though hard, and losses of limbs in the tops by storm are frequent. As a result the branches are usually diseased, very frequently the trunks are invaded by fungi, and fully 33 to 66 per cent. of the hill trees are badly rotted. Trees standing in flats or in valleys where there is a moderate amount of water are more commonly sound. Unsound trees are often betrayed by the finely twigged condition of the main branches. In the hill country of the Cottonwood Creek region in Tehama County many square miles of badly diseased trees were observed in 1899. The conditions for the growth of the fungus seemed extremely favorable and only the merest rim on the outside of limbs was not invaded. The largest limbs, in log-like sections, so cumbered the ground that the riding and pack animals could only pick their way tediously across the country.

While the wood has no value for constructive purposes, except for posts (whence "Post Oak"), it is used for fuel and has been so largely drawn upon for this purpose that the first-growth has quite disappeared from many sections in the Sierra foothills. The cordwood as fuel commands a higher price than Valley Oak, but a less price than Live Oak. The fungus, referred to above, is often seen in the gathered cordwood as mycelial threads or punk-like pieces. A settler's cabin is sometimes burned by a portion of the light matted fungus or "punk" being carried up the chimney onto the roof.

The growth of the tree is usually slow and the wood is close-grained. A tree fifteen inches in diameter inside the bark showed one hundred and sixteen rings on a count made by Mr. Ralph Hopping at Kaweah. In felling trees one occasionally finds sections of wood which are black, so extremely dense and hard that they will turn the edge of an axe; whence the folk-name, "Iron Oak."

Aged stumps do not send up sprouts, although adult trunks will sucker if not cut too far down. Sprouts often grow three feet high in one season. While remarkably weak in vegetative reproduction, seed is abundantly produced and young growth from seed is in many places fully replacing the cut trees even in pastured lands. This is because cutting for fuel has been gradual and seed trees provided the acorns for the new stand. The acorn crop in the Sierra foothills is one of the variable assets of the ranchman for stock feed.

Blue Oak has many common names. Besides those cited above, it is called Douglas Oak, in honor of David Douglas, the celebrated Scotch botanist and explorer who collected specimens of the tree on his visit to California in 1830. One of the ranchmen's names is Jack Oak, and in many localities it is simply called White Oak. The fuel is most commonly sold under the name of Mountain Oak.

Passing through the long heat of the protracted rainless season it is not uncommon to find the foliage in early autumn all crisp brown, ready to fall at a touch. At higher altitudes or in more protected situations it turns to a dull golden brown by late autumn. The young leaves appear about the middle of March. Sometimes foliage branchlets are frost-killed, as observed one year on the Nacimiento River, and a short twiggy growth clothes the main limbs.

Not in itself an attractive tree, the Blue Oak by reason of its form, color, and habit plays a strong and natural part in the scenery of the yellow-brown foothills. Always scattered about singly or in open groves, the trees are well associated in memory with bleached grass, glaring sunlight and dusty trails, although for a few brief days at the end of the rainy season the white trunks rise everywhere from a many-colored cloth woven from the slender threads of innumerable millions of flowering annuals.

### 4. **Quercus Engelmannii** Greene.

Mesa Oak.

Quercus Engelmannii Greene, West. Am. Oaks, p. 33, pl. 15, figs. 2, 3, pl. 17 (1889); Sargent, Silva N. Am., vol. 8, p. 83, t. 387 (1895); Abrams, Fl. Los Angeles, p. 105 (1904).

*Quercus oblongifolia* Engelmann in Bot. Cal., vol. 2, p. 96 (1880) in part.

Spreading tree 15 to 40 feet high, with trunk ½ to 3 feet in diameter; leaves blue-green, oblong, obtuse, entire or sometimes toothed, ¾ to 3 inches long, but most commonly 1¼ to 1¾ inches long, ⅝ to 1 inch wide; acorns 1 or 2 in a place, ripe in first autumn; cup ¾ inch broad, shallow or sometimes bowl-shaped, with warty scales, enclosing nearly ½ the nut which is sub-cylindrical, ½ inch long and about as thick, or 1 inch long, relatively less thick and sometimes acute.

The Mesa Oak inhabits the low hills of San Diego County, fifteen or twenty miles from the sea (where it is abundant) to Oak Knoll (near Los Angeles) and San Gabriel. It ranges south into northern Lower California and apparently ranges north into the San Carlos Mountains and Mt. Hamilton Range. The leaves remain on the tree until the appearance of the new leaves in the spring, whence the name "Evergreen White Oak."

5. **Quercus dumosa** Nutt. Scrub Oak. Montane shrub, 2 to 5 or 8 feet high, with tough, rigid branches and branchlets; leaves typically oblong to elliptic or roundish, entire or more commonly sinuately spinose or sinuate-lobed with sharply cut or angular sinuses, ¾ to 1 inch long; acorns ripe in first autumn, usually borne in clusters of 2 or 3; cups shallowly or deeply saucer-shaped, 5 to 8 lines broad, 2 to 5 lines deep, often rusty, the scales tuberculate, sometimes so regularly so as to suggest a quilted cushion; nuts oval to cylindric, usually rounded at apex, ¾ to 1⅛ inches long.

The Scrub Oak, which is an important member of the chaparral communities, is abundant in Lower California and in Southern California in the cismontane region, and ranges northward into the Coast Ranges, at least as far as the Vaca Mountains. It is common in the southern Sierra Nevada in the Kaweah basin, but has been rarely collected northward. It was first discovered by Nuttall near Santa Barbara in 1835. It is variable in fruit characters and decidedly eccentric in foliage, both in outline and in indentation of margin. An intelligent and practical understanding of even its most troublesome variations may be had by a study of the leaf forms exhibited by a single clump of bushes and especially by a series of critically selected branchlets derived from a single individual.

Var. **munita** Greene, West Am. Oaks, p. 37, pl. 20 (1889). I cannot distinguish this from ordinary undulate sinuate-spinose leaf forms of the species, but I have not seen the type specimens. The type was collected "along Sweetwater Creek in Eldorado County." Specimens in flower from the original locality collected in 1907 by the original collector do not seem different from ordinary *Quercus dumosa.*

Var. **Alvordiana** Jepson (*Quercus Alvordiana* Eastwood, Cal. Acad. Sci. Occ. Pap., no. 9, p. 48, pl. 27, fig. 4, 1905). Brittle-leaf Oak. Leaves thickish, obscurely but seemingly densely tomentulose beneath, entire or irregularly and coarsely serrate, oblong, 10 to 15 lines long; cup 4 to 7 lines in diameter, 2 to 3 lines deep, turbinate-cupuliform, small for the thickness of the nut, its scales ovate, acute, flat or only slightly thickened towards the base; nut 1⅝ inches long, ½ inch in diameter at widest part, tapering gradually to apex.[45]

The Brittle-leaf Oak was collected in San Emigdio Cañon, Coast Ranges of Kern County, by Miss A. Eastwood, November 2, 1894. The same thing in excellent material sent by S. C. Lillis is found in the San Carlos Range, one hundred and thirty miles northerly. The above diagnosis is derived entirely from the type specimen in the California Academy of Sciences.

The original description, cited above, is as follows: "Small tree or shrub on hills near the desert. Leaves small, brittle and easily falling, dentate. Branches tough, widely spreading. Acorns long and very slender, with small, rather smooth cups. A little known oak in the mountains connecting the Coast Range with the Sierra Nevada at the southern end of the San Joaquin Valley bordering the deserts. It is named in honor of the late William Alvord, a former president of the California Academy of Sciences."

Var. **turbinella** Jepson (*Quercus turbinella* Greene). Grey Oak. Small rigid shrub; leaves pale on both surfaces, glabrous, finely reticulated below, oblong to broadly elliptic, rigid but brittle, spinosely dentate, ¾ to 1 inch long;

[45] The central upper figure on p. 293, Forest Trees of the Pacific Slope, by Sudworth, would appear to represent this variety.

cups gray, rather shallow, 5 to 7 lines in diameter, their scales closely woven, puberulent but not at all or scarcely tuberculate; nuts slender-ovate, acute, 5 lines in diameter and about 1 inch long, the shell within quite glabrous.

This shrub is regarded by the writer as essentially identical with the form collected by G. W. Dunn in northern Lower California and near Campo, San Diego, and described by Greene as *Quercus turbinella* (West Am. Oaks, p. 37, -1889; p. 59, t. 27, -1890).

6. **Quercus durata** Jepson. LEATHER OAK. Low spreading shrub with rigid branches 2 to 5 feet high; foliage and branchlets closely woolly when young, at least minutely so in age; leaves oval, dentate with equal or nearly equal prickly teeth, the upper surface convex with more or less revolute margin, 1 to 1¾ inches long; cup 8 to 9 lines broad, 4 to 5 lines deep, the scales strongly tuberculate; nut short thick cylindric, obtuse, 7 to 9 lines long.

San Carlos Range, 2500 to 5000 feet, forming extensive pure thickets on the higher slopes and summits; westward to the Santa Lucia Mountains and northward to Mt. Diablo and the Napa Mountains. This species is taken to be the equivalent of *Quercus dumosa* var. *bullata* Engelm., Trans. St. Louis Acad., vol. 3, p. 393 (1877), and of *Quercus dumosa* var. *revoluta* Sargent, Gard. and For., vol. 8, p. 93 (1895). The author's judgment as to its distinctness from *Quercus dumosa* Nutt. rests mainly on field studies of the two species as they occur in the San Carlos Range.

7. **Quercus Sadleriana** R. Br. Campst. DEER OAK. Shrub mostly 2 or 3 but even 8 feet high with several stems from the base; leaves persistent through the winter and until after the new leaves appear in the next summer, oblong-ovate to broadly ovate, 3 to 4½ inches long, the lateral nerves regular and parallel, prominent on the under surface and ending in the teeth of the margin; stipules oblanceolate, ½ to ¾ inch long, fur-like on account of their dense covering of rusty hairs and persisting as long or even longer than the leaves; staminate catkins simple (rarely in clusters of 2 or 3 on a common peduncle), 1 to 2 inches long, borne in the lower axils of the season's shoot; calyx-border hairy and much cleft; stamens varying from 5 to 17, even on one bush; pistillate flowers solitary in the upper axils of the shoot; acorn maturing in the first autumn, its cup enclosing about ⅓ of the nut which is oval and about ¾ of an inch long.

The Deer Oak is gregarious and forms thickets at 4000 to 9000 feet altitude in the high ranges of northwestern California from Trinity Summit to Curry County, Oregon. It is abundant on Marble Mountain, where it often colonizes exclusively the open ridges. It is likewise abundant in the Klamath Range and in the Siskiyous. While most abundant on open slopes it is shade-tolerant and is common beneath the extensive White Fir forests of the region. The

effect of the weight of the winter snow on the bushes is shown on steep slopes where the very base of the stems lie along the ground, down hill, and then gradually ascend with the tops curving regularly upward.

The acorns are eaten by deer and by bear, whence the folk names "Deer Oak" and "Bear Oak." The kernel is sweet and fairly palatable, even to the white man. While trailing the western Siskiyou country, I noticed that the mules of the pack train ate greedily of the foliage in preference to that of other chaparral.

This species of oak was first discovered by John Jeffrey in southern Oregon. It was next collected by Robert Brown, a Scottish traveler and student of trees, who journeyed across the northwest corner of California in 1865 and who afterwards named this singular bush in honor of his friend, John Sadler of the Edinburgh Botanic Garden. In the literature it is called Sadler Oak. It is the most restricted in its distribution of any Californian oak. Being of the class of Chestnut Oaks, as is obvious from its foliage, it has no near relatives among the Californian species.

### 8. **Quercus tomentella** Engelm.

ISLAND OAK.

QUERCUS TOMENTELLA Engelmann, Trans. St. Louis Acad., vol. 3, p. 393 (1877), and in Bot. Cal., vol. 2, p. 97 (1880); Sargent, Silva N. Am., vol. 8, p. 109, t. 402 (1895).

Round-headed tree usually 25 to 40 feet high; bark gray-brown, smoothish or checked; leaves elliptic to oblong, light green above, paler beneath and densely fulvous tomentose when young, more or less glabrate in age, 2 to 3½ inches long, ¾ to 1¾ inches wide; nerves regular, parallel and very strong beneath, ending in the teeth of the margin, or the margin sometimes entire; acorns ripe in second autumn; cup 1 to 1½ inches wide, ½ to ¾ inch deep, its scales concealed by a dense tomentum, the elongated tips quite free; nut subglobose with a short bluntish point, about 1 inch long.

The Island Oak is a strictly insular species. It was first discovered on Guadalupe Island by Dr. Edward Palmer and has since been found on Santa Cruz, Santa Rosa, San Clemente, and Santa Catalina islands. It is the rarest of all western oaks. Scarcely more than a subspecies of *Quercus chrysolepis,* it may be retained on account of its tomentose leaves and remarkable acorn cups.

## 9. **Quercus chrysolepis** Liebm.

### Maul Oak.

Plate 69, figs. 1-6.

Quercus chrysolepis Liebmann, Dansk. Vidensk. Selsk. Forhandl., 1854, p. 173; Bentham, Pl. Hartweg, p. 336 (1839); Torrey, Bot. Mex. Bound., p. 207 (1858), Bot. Wilkes, p. 459 (1874); Bolander, Proc. Cal. Acad., vol. 3, p. 231 (1866); Engelmann, in Bot. Cal., vol. 2, p. 97 (1880); Kellogg, For. Trees Cal., p. 60 (1882); Greene, West. Am. Oaks, p. 39, pls. 21, 22 (1889); Sargent, Silva N. Am., vol. 8, p. 105, tt. 398, 399 (1895); Jepson, Fl. W. Mid. Cal., 143 (1901).

Forma grandis Jepson, Fl. Cal., pt. 2, p. 358 (1909). Forma pendula Jepson, l.c. Forma Hansenii Jepson, l.c., p. 359. Forma nana Jepson, l.c.

*Quercus fulvescens* Kellogg, Proc. Cal. Acad., vol. 1, ed. 2, p. 70 (1855); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 27, fig. 5 (1857).

*Quercus crassipocula* Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 137 (1857), vol. 5, p. 365, pl. 9 (1857).

Tree commonly 15 to 60 feet high or on exposed mountain summits reduced to a mere shrub a few feet high; trunk 1 to 5 feet in diameter, the whitish bark about ½ inch thick and fissured into narrow flat, more or less scaly ridges; leaves commonly 1 to 2 but sometimes even 4 inches long, thick, green above, yellow beneath with a fine fuzz or powder, or eventually lead-color or dull white, ovate or oblong-ovate, acute at apex, entire, or with entire and toothed leaves frequently found on the same twig; staminate catkins ½ to 1½ (or 2) inches long, the calyces unequally lobed and containing 8 to 10 stamens; pistillate flowers mostly sessile and solitary, or sometimes in short spikes; acorns maturing in second autumn; typical cup thick and round-edged, its diameter conspicuously greater than the nut, with a fine fuzzy or felt-like tomentum concealing the scales, the whole suggesting a yellow turban, but thinnish cups and scanty pubescence not concealing the scales occur as frequently; nut ovate, globose, or cylindric, rounded at apex or sharply pointed, 1 to 1¼ inches long, ¾ to 1 inch broad.

The Maul Oak is almost entirely confined to the cañons, slopes, and summits of mountains and lives under a wide variety of conditions from southern Oregon to Lower California and eastward through Arizona to New Mexico. While found throughout this region wherever the mountains rise to sufficient altitude, and so not rare, the trees are commonly scattered one here and one there, and are seldom found in any great numbers and never in pure forests even of limited extent. The comparative scarcity of Maul Oaks may be partly accounted for by the attacks of grubs upon the kernels of acorns, the eggs having been deposited in the ovary. Reproduction by stump sprouts, however, is persistent and abundant, the foliage of such shoots being characterized by their spininess.

In the Sierra Nevada the species is most common and of largest size between 1500 and 5000 feet, being chiefly confined to the cañons. Round balls of Maul Oak shrubs cling to the rocky walls and talus in all the great cañons of the Sierras, such as the Kern, Kings, Yosemite, and Hetch-Hetchy.

In the cañons of the San Bernardino Mountains the altitudinal range, according to Parish, is 1500 to 5000 feet on the southern and 5000 to 6000 feet on the northern (or Mohave) slope. On the Oak Glen ranch in these mountains is the largest tree reported from Southern California. It is seventy feet high with a trunk seven feet six inches in diameter at eighteen inches above the ground. In number of individuals Maul Oak is more abundant on Mt. San Jacinto than I have seen it elsewhere. On the dry, open slopes between 4000 and 6000 feet, we have trees only ten to twenty feet high, the trunks dividing near the base into wide-spreading limbs which form a low, broad head or even trail out over the ground. This is one of the common forms of Maul Oak and is especially typical of dry, open situations. Again one may see it in adjacent cañons but a few hundred yards distant, where crowded by conifers, with trunks unbranched for thirty-five feet.

In size of individuals it reaches its greatest development in Mendocino and Humboldt counties, where the most massive trees grow on bottom lands in the valleys. The narrow floor of Hope Valley is distinguished by its Maul Oaks, their great size and port. One of these trees, named "Old Sentry," is ninety-five feet high and one hundred and twenty-five feet across the crown the longest way. The trunk is slightly over six feet in diameter at four feet six inches from the ground. Considering all of its dimensions this is the largest known Maul Oak. Trees of similar massiveness also occupy little shoulders or knolls on mountain sides where they are exempt from the full force of forest fires. By the side of the coast road on the ridge between Endsie's Cabin and the ford of the Mattole River there is a tree in such a situation which is seventy-five feet high and ninety feet in crown diameter; the trunk is seven feet eight inches in diameter at three feet four inches from the ground, which is the point of least circumference. This tree is matched by many more along the Blue Rock Ridge in northern Mendocino. They often bear long, declining branches, the crown thus conforming to the shape of the hill which they inhabit.

The tallest and, by reason of their habit as well as height, the finest trees grow on the sharp walls of deep, cool cañons, and as such habitats so commonly exhibit well-developed trees the species is often called Cañon Oak.[a] Clean, free trunks, twenty to forty feet in height usually characterize Cañon Oaks. At one time the beautiful Mill Creek Cañon near Ukiah, now State property, contained hundreds of fine trees, but many of them have been cut for the sake of their valuable wood. Those which remain are mostly sixty to one hundred feet high

[a] This form is diagnosed below as forma *grandis*.

with trunks two to five feet in diameter. The trunk of one tree, standing on the edge of the flat, well up the cañon, is five feet and six inches in diameter at four feet above its base and almost or quite maintains its girth to thirty-five feet where it parts into two large branches giving rise to the crown, the very top of which is one hundred and ten feet above the ground.

The wood of Maul Oak is remarkable for its strength, toughness, and close grain; for these reasons and because of its freedom from checks in seasoning it is more valuable than that of any other California oak. It is used for frames and knees in shipbuilding, for wheels, axles, and poles in wagon-making, for plow-beams, hoe-handles, and single-trees, and for furniture. On account of ignorance of its value it is often cut for fuel. By reason of the hardness and solidity of the wood it is everywhere used for the heads of mauls and is most widely known as Maul Oak. For the best mauls young trees six inches in diameter are selected. The wood is very heavy, almost as heavy when it is dry as when "green." It is also a favorite wood for "slugs" or "bucks," flat-pointed wedges with iron-rimmed heads for splitting Redwood into ties. The old-time saying that the wood of California oaks is valueless is quietly ignored by certain manufacturers who make free use of Maul Oak, in so far as they are able to get it, for furniture and oak floors.

No other Californian oak has so many folk-names in use. Being evergreen it is called Live Oak or Mountain Live Oak, especially in those portions of the mountains where it is the only live oak; in other places it is termed Cañon Oak, Drooping Oak, or White Live Oak since it is one of the White Oaks. Woodsmen frequently know it as Spanish Oak, Valparaiso Oak, Georgia Oak, and Florida Oak. On account of the pollen-like powder on the under side of the younger leaves it is famed as Gold-leaf Oak or Golden Oak, while certain shapes of the leaves explain the term "Laurel Oak." "Iron Oak," "Pin Oak," and "Hickory Oak" are names which, like Maul Oak, speak the respect of the ranch man for its wood.

*Quercus chrysolepis* is the most variable of western oaks, certainly so in its acorns, markedly so in leaf eccentricities, and strikingly so in habit. Variation in leaf outline is a characteristic feature of Maul Oak. While the oblong or ovate medium-sized type of leaf, entire or less commonly toothed, is a prevailing form, wide departures are exceedingly frequent. Long tapering willow-shaped leaves, narrow entire leaves, large elliptic leaves (entire or toothed mostly towards apex), small sharply toothed leaves—such are a few of the eccentric forms. On bushes or vigorous shoots the leaves are sometimes roundish and sometimes oblong-ovate but are usually very spiny-toothed and vary in size from a half inch to two inches.

As a diagnostic test of a foliage specimen, the characteristic hue of the under side of the leaf, golden when young, lead-colored in age, is more to be re-

lied upon than mere size or outline of the leaf. Variation in the acorn affects both cup and nut almost equally, which is not usual in California oaks. The typical cup is broad and thick, sometimes so very thick as to suggest by its moulding a Mexican cartwheel and also to earn the name "Thick-cup Live Oak," but thin saucer-shaped cups are as commonly found. Some trees bear acorns with small shallow cups and narrow nuts, others very thick cups and pointed nuts, others still display medium cups and oblong nuts. The bark, which is the thinnest of any Californian arboreous oak, is broken on the surface into narrow ribbons which are somewhat loosely interwoven, or again it may be covered with scales which flake off. A few forms are here described:

Forma **grandis** Jepson. Canon Oak. (Plate 69, fig. 5.) Tall tree with straight trunk and narrow crown 60 to 110 feet high; cups 6 to 9 lines broad and 4 to 5 lines deep, the scale-tips not involved in the dense close felt which is scantier than in the type; nuts oblong, 1 to 1⅛ inches long, obtusish or sub-acute.—Narrow North Coast Range cañons, fine examples in Mill Creek Cañon near Ukiah, as specially described above.

Forma **pendula** Jepson. Broad-crowned tree with pendulous branchlets; leaves oblong-lanceolate to broadly lanceolate, 2 to 4 inches long, ½ to 1 inch broad, disposed to be entire, deep shining green above.—Upper San Benito River. Similar if not identical forms occur in El Dorado and Amador counties.

Forma **Hansenii** Jepson. (Plate 69, fig. 6.) Low tree; leaves ovate, acute, 1¾ to 2½ inches long, the nerves below chiefly straight, regular and parallel; nut cylindric, about 10 lines long, and 3 or 4 lines in diameter, set in a thick cup of greater diameter.—Pine Grove, Amador County, 2300 feet, Geo. Hansen in 1895.

Forma **nana** Jepson. Low compactly branched shrub; leaves oblong or ovate, acute, ⅞ to 1½ inches long; cup shallow, 7 or 8 lines broad; nut thick, ovate, blunt, ¾ to 1 inch long.—Mt. St. Helena and other high Coast Range summits.

10. **Quercus vaccinifolia** Kell. Huckleberry Oak. (Plate 69, figs. 7, 8.) Shrub, prostrate or erect and 2 to 6 feet high, the slender pliable branchlets in tufts at top of stems, simulating the habit of a huckleberry; leaves oblong-ovate, mostly obtusish or only sub-acute, commonly entire, pale green above, often tan-color beneath, mostly ¾ to 1⅛ inches long or less; stamens 6 to 11; cups broadly turbinate or shallow bowl-shaped, thinnish, not fulvous-tomentose but merely pubescent, 3 to 4 lines broad; nuts globose-ovate, rather abruptly drawn down to a short point, 4 to 6 lines long, 4 to 5 lines broad.

The Huckleberry Oak grows at high altitudes (6000 to 9000 feet) throughout the Sierra Nevada and high North Coast Ranges, and often occurs in great abundance, forming extensive thickets. No one who has seen either the prostrate form growing over rocks, or the gregarious form on steep hill slopes with

its slender vaccinium-like stems and foliage and remarked its small entire leaves destitute of fulvous tomentum and its tiny acorns, could well believe this to be conspecific with that arboreous Maul Oak (*Quercus chrysolepis*) which bears large variable leaves, wheel-shaped acorn cups and large oval nuts. Yet even in its most marked form the leaves of this bush are sometimes toothed and often as large as the ordinary bush form of the Maul Oak. Its acorn cups while very different from the type, as said, are scarcely more different than those of forma *grandis* described above and its nuts are scarcely more unlike than the pencil state called forma *Hansenii*. The nut most representative of this shrub has a subglobose body rather abruptly drawn down above to a short acute point and set in a thin shallow cup. If the truly vaccinium-like forms displayed only this type or approximately this type of acorn, this species could be sharply segregated. As it stands, numerous variable intermediate forms are not thereby satisfactorily disposed of. Nevertheless it is here exceedingly convenient to retain it as an ecological subspecies.

11. **Quercus Palmeri** Engelm. PALMER OAK. Rigidly branched shrub 5 to 15 feet high; leaves typically elliptic to nearly orbicular, wavy-spinose, undulate, coriaceous and stiff, olivaceous above, pale or whitish beneath, ½ to 1½ inches long, when young sparingly pubescent on the upper surface and with a dense but thin yellowish or later white felt on the lower surface; staminate catkins ½ to 1½ inches long; acorns ripe in second autumn; cup thinnish, subturbinate but shallow, 5 to 7 lines broad, 3 to 4 lines deep; nut ovate, the shell tomentose within; cotyledons purple, separable.

The Palmer Oak grows in the mountains of Southern California from Vandeventer's Ranch in the San Jacinto Range southward into Lower California. The staminate catkins are disposed to ascend as in some other oaks, but are not stiffly erect as in the chestnuts with which this species has been compared (Greene, West Am. Oaks, p. 55, pl. 25, 1889).

### 12. **Quercus agrifolia** Neé.

COAST LIVE OAK.

Plate 70, figs. 3, 4; plate 71.

QUERCUS AGRIFOLIA Neé, An. Cien. Nat., vol. 3, p. 271 (1801); Torrey, Pac. R. Rep., vol. 4, p. 138 (1856); Nuttall, Sylva, vol. 1, p. 16, pl. 2 (1865); Bolander, Proc. Cal. Acad., vol. 3, p. 229 (1866); Hooker, Icon., vol. 4, t. 377 (1841); Engelmann, in Bot. Cal., vol. 2, p. 98 (1880); Kellogg, For. Trees Cal., p. 63 (1882); Greene, West Am. Oaks, p. 7, pl. 5 (1889), Erythea, vol. 2, p. 44 (1894); Sargent, Silva N. Am., vol. 8, p. 111, t. 403 (1895); Jepson, Erythea, vol. 7, p. 131 (1899), Fl. W. Mid. Cal., p. 143 (1901).

Var. FRUTESCENS Engelmann, Bot. Cal., vol. 2, p. 98 (1880).

*Quercus oxyadenia* Torrey, Sitgreaves' Rep., p. 172, pl. 17 (1853).

"Stately lords of the forest," Vancouver, Voy. Discov., vol. 2, p. 17 (1798).

Low broad trees, with open or as often very dense crowns, as much as 60 or 70 but usually 20 to 35 feet high, the short trunk parting into erect limbs or more commonly into crooked, widely spreading branches which often touch or even trail along the ground; bark smooth and beech-like, or sometimes fissured, dark brown or gray on the surface, reddish or pink inside, very brittle when fresh, 1 to 2¼ inches thick and clothing a trunk 1 to 4 feet in diameter; leaves roundish, elliptic, sometimes ovate or oblong, usually with spine-tipped teeth or entire, commonly 1 to 2½ inches long but varying from ½ to 4 inches, usually convex above; staminate catkins 1 to 1½ inches long, deep red; stamens 4 to 8; pistillate flowers set in the upper axils of the season's shoot; styles 4 or sometimes 3; acorns 1 in a place or in clusters of 2 to 5, maturing in the first autumn; cup broadly turbinate, 4 to 7 lines deep, embracing the base of the pointed nut; nut 1 to 1½ inches long, 5 to 7 lines thick.

The Coast Live Oak, or Encina of the Spanish Californians, is distributed in the Coast Ranges from Sonoma County to Southern and Lower California and is the only evergreen oak ordinarily met with in the limits of its distribution. Fine individuals may be found in many of the Coast Range valleys. There are beautiful trees seventy-five to eighty feet high in the Russian River Valley at Cloverdale. Trees of similar port may also be seen in Napa Valley, Santa Clara Valley, San Ignacio and other valleys about Mt. Diablo, the easterly slope of the Santa Inez Range near Mission Santa Inez, cañon of the Santa Rosa Ranch in the Santa Ana Mountains, and so on southward. The largest known individual grows in the fertile Ojai Valley; its crown is 105 feet across while the trunk has a diameter of six feet and eight inches at five feet from the ground. Another tree, imperfect and in extreme old age, measures one hundred and twenty feet across the crown.

While the largest trees and most extensive groves are found in the valleys, or on shelf-like flats in the hills, it grows also in the hill country, sometimes in great abundance though chiefly in a reduced or even shrub-like form. In the low shrub-like form, as in the Oakland Hills, it is var. FRUTESCENS Engelm. The hill trees love the ravines, they fill dry gulches, especially on barren exposed hills, and they become intensely gregarious in sharply defined colonies on northerly hillsides or swales. Again they may colonize the summits of basaltic ridges or be scattered about on open slopes in a manner similar to the valley trees and in all cases they most frequently occur without admixture of other species. Although the leaves are often smaller or more prickly, the Live Oaks of the hills differ in no technical particular from the valley type. When the hill trees stand in the path of high wind currents the trunk and crown often trail along the ground, hence "Creeping Oak."

The northern limits of its distribution have not been exactly defined. "As far north as Mendocino County," says the Botany of the California Geological Survey, a statement repeated by Sargent in the Silva. Nevertheless the

beautiful trees in the Ukiah Valley and on the slopes north of Willits, as well as the shrub forms in the mountains, are not of this species; they are Interior Live Oak (*Quercus Wislizenii*). Altitudinally Coast Live Oak (*Quercus agrifolia*) ascends to 2000 feet in the north and to 4500 feet in the south, as on the San Jacinto Range, where there is a grove of fine trees at Vandeventers Ranch.

The production of acorns is usually fair and often abundant although not all trees take part in an annual crop. They germinate freely, but like those of all oaks are very sensitive to dryness; comparatively few or sometimes none survive even short dry periods following the first rains. Reproduction also occurs by stump sprouts although weak or uncertain in old trees. The age of adult trees varies from one hundred to one hundred and fifty years.

The Coast Live Oak is periodically subject to the ravages of the tent caterpillar[47] which are especially abundant every third and fourth year. They appear from May to July and destroy the foliage so completely that to the casual eye the tree appears dead or in naked winter condition. The visitations of 1904 and 1905 were severe. In those years fully 25 per cent. of the trees in the North Coast Ranges lost their leaves. A spray of paris green will prove effective against these insects and may be used for the protection of trees standing in villages or private grounds. The remedy should be applied when the tents are quite small, or in the case of the oak caterpillar, which also injures the oaks, when the moths are seen about the crown in great numbers.

Here and there one finds groves which are past maturity and in which natural regeneration has not kept pace with the losses from disease or old age. The trees on the campus of the University of California are very picturesque but at the same time very old. In order to lessen the death rate it has been found necessary to prevent tramping of the earth about the trunks by passing feet, to avoid filling of earth about trunks in grading, to maintain lawns or restore and preserve the leaf-mould under the crowns, and to supply by irrigation an amount of water equivalent to that which has disappeared from the creek running through the grove by reason of having been diverted long ago at the higher sources and springs for household use and other purposes. The process of dry rot in the trunks and limbs can be retarded by preventing the accumulation of rainwater in the hollows and knot-holes. The practice at Berkeley is very successful as a form of tree surgery. The hollows are thoroughly cleaned, with special tools where necessary in order that all of the infected wood possible may be removed, scarified with a gasoline flame, painted with coal tar, tamped tightly with cement filled even with the wood, and the surface painted with a lead paint. Dead branches are sawed off flush with the limb and the cut surface merely painted if the wood be sound. Such continued care will prolong the lives of the aged trees until young trees now planted be

[47] Woodworth, Univ. Calif. Agr. Exp. Sta. Circ. no. 18 (1906).

old enough to replace them. The famous Le Conte Oak without treatment could scarcely have lived longer than fifteen years. With care and with sufficient water no one may at present forecast its death.

The wood of *Quercus agrifolia* is hard, heavy and moderately strong. It has been used for ship knees, to a limited extent in wagon-repairing, and for fuel for which it is well adapted. For the latter purpose it has a higher value and commands a higher price than the Valley, Blue, or Kellogg Black Oak. Moreover the hill trees are, for cordwood, preferred to the valley trees. The wood splits easily when dry and is thus readily worked into short-length stovewood. In certain localities the trees are converted into charcoal. During the drought years of 1897 and 1898 resort was had to the Live Oaks to save the lives of cattle in the South Coast Ranges, small trees and branches from large ones being cut for browsing.

Coast Live Oak is almost universally known among the people simply as Live Oak, or rarely as Field Oak. It is sometimes called Holly-leaved Oak or Holly Oak, a rather happy common name but lacking the force of usage. The specific name, *agrifolia,* is simply one of the forms of the old Latin name of the holly.

This species was first collected by the Malaspina Expedition in 1791, the first and last scientific expedition sent by Spain to her remote province of Alta California. The botanists of the expedition were Thaddeus Haenke and Luis Neé. The ship anchored for some time at the port of Monterey, where Haenke botanized, Neé having stopped in Mexico until the return of the expedition from the north. Specimens of two oaks were, however, gathered by ship's officers and given to Neé, who published at Madrid a description of them in the Anales de Ciencias Naturales. In his account of *Quercus agrifolia* he says that he cannot give the height of the tree of which he has seen only branches gathered by Don Joseph Robredo and Don Manuel Esquerra, who also collected the Valley Oak. These were the first specimens of California trees to reach Europe and these two species are in many ways the most interesting.

Throughout the coast region, except in the extreme north, this Live Oak is the most common and characteristic tree of the Coast Range valleys, which it beautifies with low, broad heads whose rounded outlines are repeated in the soft curves of the foothills. Disposed in open groves along the bases of low hills, fringing the rich lands along creeks or scattered by hundreds or thousands over the fertile valley floors, these characteristic trees attracted the attention of the early Spanish explorers who remarked the thick foliage of the swelling crowns and associated with the Encina, as they termed this species, the fertility of the land and its desirability for residence. The chain of Franciscan Missions corresponded closely to the general range of the Live Oak, although uniformly well within the margin of its geographical limits both eastward and

northward. The vast assemblage of oaks in the Santa Clara Valley met the eye of Portola, discoverer of San Francisco Bay, in 1769,[48] and a few years later, Crespi, in the narrative of the expedition of 1772, called the valley the "Plain of Oaks of the Port of San Francisco." Then came Vancouver, Englishman and discoverer. Although he was the first to express a just estimate of the Bay of San Francisco, which he declared to be as fine as any port in the world, nevertheless it is in his felicitous and appreciative description of the groves of oaks, the fertile soil (of which they were a sign), and the equable climate that one reads between his lines of 1792 the prophecy of California's later development.

### 13. **Quercus Wislizenii** A. DC.

#### Interior Live Oak.

Plate 70, figs. 5-7; plate 72.

Quercus Wislizenii A. DeCandolle, Prodr., vol. 16, pt. 2, p. 67 (1864); Engelmann, in Bot. Cal., vol. 2, p. 98 (1880); Kellogg, For. Trees Cal., p. 107 (1882); Greene, West Am. Oaks, p. 5, pl. 3, 4 (1889); Coville, Bot. Death Val. Exped., p. 197 (1893); Sargent, Fl. N. Am., vol. 8, p. 119, t. 406 (1895); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For. Res.), pp. 516, 519 (1900); Jepson, Fl. W. Mid. Cal., p. 144 (1901).

Var. frutescens Engelmann, Bot. Cal., vol. 2, p. 99 (1880).

*Quercus agrifolia* Torrey, Pac. R. Rep., vol. 5, p. 365 (1857), not Neé; Bot. Wilkes, p. 460 (1874), in part.

Live Oak, Fremont, Rep. Second Exped., pp. 241, 243 (1845).

Round-headed tree most commonly 30 to 75 feet high; trunk 1 to 3 feet in diameter with a thick brittle bark which is very smooth or sometimes roughly fissured; leaves typically oblong (varying to elliptic, ovate or ovate-lanceolate), either tapering to apex or rounded, 1 to 2½ (or 4⅔) inches long, green and shining above, pale yellowish green below, finely netted-veined on both surfaces, the margin entire, or spiny-toothed; staminate catkins 2 to 3 inches long, sometimes borne in great profusion, 30 to 40 from a cluster of terminal buds; calyx-lobes 4 or 5, hairy pubescent, separated nearly to base or some in same calyx united nearly to summit; stamens 4 to 8; acorns ripening in second autumn, borne in clusters of 2 or 3 or singly; cup deeply cup-shaped to turbinate, embracing ¼ to ½ the nut, 6 or 7 lines broad, composed of thin red-brown scales; nut cylindric and tapering to the apex or conical, often longitudinally banded with dark lines converging at the summit, 1⅛ to 1⅝ inches long.

The Interior Live Oak[49] is found in the Sierra foothills, mostly in ravines and cañons but often in gravelly soil or on the driest slopes, ranging to 1500 or

[48] Diary of Gaspar de Portola during the California Expedition, edited by D. E. Smith and F. J. Teggart (Acad. Pac. Coast Hist. Publ., vol. 1, no. 3, 1909).

[49] It is almost universally known in the field simply as Live Oak.

2000 feet at the north and 3000 or 4500 feet at the south. It follows the water-courses down into the Great Valley where it was and often still is abundant along the banks of creeks and in river bottoms or prairie uplands, forming beautiful groves of scattered trees which give a proud character to the rich lands on the eastern side of the Sacramento and San Joaquin valleys. It also grows along streams on the western side of the Sacramento Valley and extends southward to Suisun Valley, where it meets the Encina or Live Oak of the Coast Range valleys, and to the Ukiah Valley, where there are notable specimens seventy-five to eighty feet high and six feet in trunk diameter, and others not so tall but with very broad crowns.

In typical trees the branches are numerous, erect in the top, spreading around the sides and down to the ground so as to conceal the trunk, thus forming a great globose ball resting on the ground with a segment cut off the lower side. The surface of the crown is a very dense weave of foliage and branchlets and one can hardly see through the tree even partially. In such trees the crown is of greater diameter than the height. This species is sometimes called Highland Oak and is the most vigorous and robust of all Californian Cupuliferae, save always the Tan Oak. One of the evidences of its vigor is that the stumps send up sprouts actively after felling.

The geographical limits of the two Live Oaks, *Quercus agrifolia* and *Q. Wislizenii,* have not been well defined in the North Coast Ranges, for it is a detailed cross-country task requiring much care. The specific distinctions between the two species are as follows:

| Typical agrifolia. | Typical Wislizenii. |
|---|---|
| Leaves roundish to elliptical, always toothed. | Leaves oblong to oblong-ovate, entire or toothed. |
| Leaves convex on upper surface, dull, or dark green, paler beneath, reticulated, the veins often ending in a small papilla or point in centre of mesh. | Leaves plane, bright or lustrous green above, pale or usually yellowish green below, finely reticulated, the veins forming an even mesh without free ends. |
| Leaves persisting until new leaves appear in March, mainly falling at once. | Leaves persisting more or less until autumn of of second year, falling gradually. |
| Acorns maturing in first autmn, borne on the shoot of the season. | Acorns maturing in second autumn, borne on the shoot of the previous year. |
| Cup comparatively shallow, covering base of nut, its scales ovoid, sub-glabrous. | Cup deep, often covering ¼ to ½ the nut, its scales long, lanceolate, flocculent-hairy. |

While the two species are thus very distinct, frontier stragglers are not always readily separated. The leaves of the Coast Live Oak are sometimes quite flat and the terminal winter buds on fruiting shoots of Interior Live Oak may remain dormant so that full grown acorns may appear to be on "one-year-old" wood. Acorns removed from the branch or picked from the ground

are sometimes not determinable, so much do certain deep-cupped forms in the two species resemble each other. Nuts short and thick or as slender as a quill are not uncommon variants in *Quercus Wislizenii* acorns.[50] These variations, which are to a large extent a matter of nutrition, are closely matched by similar variations in *Quercus agrifolia.*

Mainly for the above reasons, the local distribution of *Quercus Wislizenii* has not been throughout its area sharply defined. The northernmost station[51] is the Sacramento River Cañon just south of Mt. Shasta, while the southernmost reported station is in the Tehachapi region. The shrub variety has been found as far south as Mt. San Pedro Martir in Lower California.

While the Interior Live Oak in tree form trespasses little if at all upon the Coast Live Oak or Encina territory, it is found throughout the same region, overtopping it, as it were, on the summits of the mountains as a low shrub. The shrub form, var. FRUTESCENS Engelmann (Bot. Cal., vol. 2, p. 98), is intricately and stiffly branched, only four to six feet high, with small, leathery leaves, and is a member of the chaparral communities. Although in number of individuals it is the least important of the chaparral shrubs, yet in the qualities which distinguish them it outdoes them all in stubbornness and unyielding resistance to the traveler's intrusion. Dwarfed yet not despicable, it accommodates itself to very dry or rocky slopes and occurs between 1500 and 4000 feet on all the higher summits of the Coast Ranges such as Uncle Sam and Elk mountains (Lake County), Red Mountain (Mendocino County), Vaca Mountains, Mt. St. Helena, Twin Sisters, Mt. Tamalpais, Mt. Diablo, Mt. Hamilton, Santa Cruz Mountains, and so on southward to the Sierra Madre, San Bernardino Mountains, and Mt. San Jacinto in Southern California where it occurs at 5000 to 7000 feet altitude. In every locality it is remarkably prolific, its burden of acorns seeming out of all proportion to the thin foliage. It is very shallow-rooted.

The wood of *Quercus Wislizenii* has a higher value for fuel than any other Californian oak and though tough and strong is seldom used for any other purpose. It rots quickly in contact with the soil, although the stumps persist a long time, decaying very slowly. The annual rings in the wood are more sharply marked off by series of ducts than in the Coast Live Oak or Encina.

The first account of the Interior Live Oak is in Fremont's narrative of his first expedition to California. He discovered it on the south fork of the American River, March 3, 1844, when crossing the Sierra Nevada from the Great Basin to the Sacramento Valley. On the journey from Sutter's Fort to reach the Spanish trail from Los Angeles to Santa Fé the expedition passed through

[50] *Quercus Pricei* Sudworth (For. Trees Pac. Slope, p. 311, 1908) is probably one of the shallow-cupped variants.

[51] It has been reported as growing in Siskiyou County. It should be searched for, since the report still lacks confirmation by specimens.

the groves on the Cosumnes, Mokelumne, Stanislaus, and other streams on the east side of the Great Valley. It was at this time that Fremont penned in his journal an admiring picture of the full and regular figures of the Live Oak, the flowering prairies between, and the herds of elk and other wild animals which enlivened the scene. Some years later, in 1851, Dr. F. A. Wislizenius, a botanist of German birth who traveled extensively in the Southwest, collected the Interior Live Oak on the American River. His specimens were sent to A. De Condolle, the celebrated Genevan botanist, who correctly took the material to represent an undescribed oak which in 1868 he named in honor of the collector.

### 14. **Quercus Kelloggii** Newb.

BLACK OAK.

Plate 70, figs. 1, 2.

QUERCUS KELLOGGII Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 28, 89, fig. 6 (1857); Torrey, Bot. Wilkes Exped., p. 463 (1874); Engelmann, in Bot. Cal., vol. 2, p. 99 (1880); Kellogg, For. Trees Cal., p. 67 (1882); Greene, West. Am. Oaks, p. 1, t. 1 (1889); Parish, Zoe, vol. 4, p. 346 (1894)

*Quercus tinctoria* var. *californica* Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 138 (1856), Bot. Mex. Bound., p. 205 (1859).

*Quercus californica* Cooper, Smithsonian Rep., 1858, p. 261 (1859); Coville, Bot. Death Val. Exped., p. 196 (1893); Sargent, Silva N. Am., vol. 8, p. 141, t. 416 (1895); Sudworth, 21st Rep. U. S. Geol. Sur., pt. 5 (For Res.), pp. 516, 532 (1900); Jepson, Fl. W. Mid. Cal., p. 144 (1901).

*Quercus sonomensis* DeCandolle, Prodr., vol. 16, pt. 2, p. 62 (1864); Bolander, Proc. Cal. Acad., vol. 3, p. 230 (1866).

Graceful tree, commonly 30 to 85 feet high, with trunk 1 to 4½ feet in diameter and mostly erect or ascending main branches; bark black or dark, on old trunks deeply checked into small plates; leaves deeply and mostly sinuately parted with about 3 lobes on each side, ending in 1 to 3 or more coarse bristle-tipped teeth, lustrous green above, lighter beneath, often white with a fine tomentum when young, 4 to 10 inches long and 2½ to 6 inches wide; staminate catkins 1½ to 3 inches long; calyx broadly cup-shaped with 4 or 5 scarious lobes, sometimes split down one side, containing 5 to 7 or 7 to 9 stamens; pistillate flowers borne singly or 2 or 3 together on a peduncle ¼ to ½ inch long; styles 3; acorns ripe in the second autumn (early in the second summer nuts completely covered by the cups, forming globose knobs about ½ inch in diameter); cup large, ½ to 1 inch deep, ¾ to 1⅛ inches broad, covered with thin scales which have a membranous and sometimes ragged margin; nut typically oblong in outline, very rounded at apex, 1 to 1¼ inches long and ¾ inch broad, covered at first with a fine fuzz and deeply set in a brown cup.

The Black Oak ranges from southwestern Oregon through the Sierra Nevada and Coast Ranges to the Cuyamaca Mountains near the southern border of

California. It is common in the Sierra Nevada, chiefly between 1500 and 4500 feet at the north and 3500 to 6500 feet at the south, where it occurs as scattered trees, or forms considerable groves at the beginning of the main timber belt, either just below the Yellow Pine or in company with it. It is commonly the only oak tree in those places in the Sierras where it is found. I have also found it on the eastern slope of the Sierra Nevada just above the mesas of Owens Valley opposite Kearsarge Pass. In Southern California it forms a part of the mixed forest at 4000 to 6000 feet on the westerly slopes of the Sierra Madre, San Bernardino, and San Jacinto ranges, and on Palomar and the Cuyamaca Mountains.

Black Oak is a most constant associate of Yellow Pine in the Coast Ranges and is commonly found with Oregon Oak, Madroña, and Tan Oak. It does not associate with the Redwood. In the inner Coast Range or in the immediate neighborhood of the coast it is not abundant and commonly infrequent. Even in its best areas it forms groves rather than forests. Nevertheless it is found in a large number of mountain ranges high and low, and is more widely distributed within the State than any other California oak. Growing on the gravelly floors of low valleys, on clay foothills, alluvial slopes, rocky ridges and high montane plateaus and slopes, it has also the greatest altitudinal range of any Californian oak, being found in Napa and Santa Rosa valleys at less than 200 feet above sea-level, and occurring as a low tree or as scrub in the Sierra Nevada and Yollo Bolly Mountains at 5000 to 8000 feet elevation.

Notwithstanding its wide range and diversity of habitat, it is, after the Valley Oak, the least variable of our species, being remarkably uniform in the features of habit, bark, leaf, and acorn. Nutrition, aside from size of the individual, affects the uniformity of the nut more than any other part. Trees bearing poorly developed acorns exhibit very narrow and often pointed nuts, but the cup character is very constant. The widest departure from type is:

Forma **cibata** Jepson, *n. form.* Frutex humilis vel sub-prostratus; folia tenuiter tomentosa.—Low or semi-prostrate shrub; leaves finely tomentose.—Yollo Bolly Mountains, 5000 to 8000 feet altitude.

Of all our oaks, fire is most destructive to this one, but if a tree is not too badly burned the main limbs will put out new foliage. Black Oak stump-sprouts freely. I have counted as many as seventy-nine sprouts from a medium-sized stump. These sprouts develop into poles which grow rapidly, showing an average growth of two feet per year for fifteen or eighteen years. On account of the strong tap-root, stumps are difficult to remove in clearing land. It is economical, therefore, to cut them squarely off at the surface of the ground that the grass mower may pass unobstructed. In several localities I have seen the shoots from these stumps like young grapevine runners sprawl over the ground

instead of standing erect. Chaparral cover favors the extension of the species, since seedlings come up well in favored situations under such protection and form considerable thickets in a few years in the absence of fire. Mistletoe attacks the trees in certain localities and eventually kills them.

At the higher altitudes the new foliage, especially in young trees, is crimson or purple for a period of one or two weeks. The purple coloration is also characteristic of young foliage appearing in summer or fall on trees that have passed through a brush or forest fire.

The wood is reddish, heavy, hard, strong but brittle. It has a value for firewood, and while inferior to Tan Oak, is sometimes preferred for household fuel. It is sometimes used for spokes, axles and similar parts in wagon-making and is employed for posts, although its life in contact with soil is commonly but four to eight years. On the whole it is a rather poor wood, but is frequently made use of by local artisans in the remoter parts of the State as in the woods of Humboldt County. The bark has been used in tanning leather.

The California Black Oak was first collected in 1846 near the Spanish town of Sonoma by Hartweg, a botanical explorer of the London Horticultural Society. It has but one folk-name, being popularly and universally known as Black Oak, because it is our only typical species of the Black Oak class. Botanists and their friends often use the common name, "Kellogg Oak." Dr. Albert Kellogg was a pioneer botanist of California, one of the founders of the California Academy of Sciences, a man of singular purity of life and high character, and a devoted student of the trees. The man's nature is well revealed in his book on the Forest Trees of California, a book to be remembered for its spiritual interpretation of the oaks and the laurel, the pines and the madroña, and the beauty of many of its passages.

### 2. Pasania Miq. Tan Oak.

Trees or shrubs with evergreen foliage and erect catkins. Staminate flowers one in a place, densely disposed in elongated simple catkins; stamens 8 to 10, 4 times as long as the 5-parted calyx. Pistillate flowers 1 in an involucre, the involucres few at the base of some of the staminate catkins; calyx often with rudimentary stamens; ovary 3-celled. Fruit an acorn, the cup with slender spreading scales.—Pasania (native name of one of the species in Java), a genus equally related to Quercus (the oaks) and Castanea (the chestnuts), is represented by one species in California and Oregon and by nearly one hundred in southern Asia and the Malay Archipelago. Both Quercus and Castanea are ancient types geologically and Pasania is of great interest as a connecting genus which has also survived to the present day.

The following parallel indicates the relationship of Pasania to its allied genera, Castanea and Quercus, as evidenced by the characteristics of *Pasania densiflora.*

| Chestnut-like Characters. | Oak-like Characters. |
|---|---|
| Parallel nerves of the toothed leaves. | Habit more like an oak than a chestnut. |
| Erect catkins. | Involucre 1-flowered. |
| Pistillate flowers in same catkins as staminate. | Ovary 3-celled. |
| Stamens of male flowers very much exceeding calyx; rudiments of stamens in pistillate flower. | Cup of the acorn a true cup and not a closed involucre. |
| Cup with suggestion of burriness. | Nut a true acorn nut. |
| Nut often vaguely triangular. | Kernel oak-like, bitter to the taste. |

It is thus seen that in the character of its male flowers Pasania is a chestnut, in the character of its female flowers and habit chiefly an oak.

## 1. **Pasania densiflora** Oerst.

### Tan Oak.

Plate 73; plates 2, 7.

Pasania densiflora Oersted, Vidensk. Medd. For. Kjobenh., p. 83 (1866); Jepson, Fl. Cal., p. 362 (1909), Trees Cal., p. 175, figs. 98, 99 (1909). Forma lanceolata Jepson, Fl. Cal., l.c., p. 363.

Var. echinoides Jepson, Fl. Cal., p. 363 (1909) = var. *echinoides* Sargent sub *Quercus densiflora* Hooker & Arnott.

*Quercus densiflora* Hooker & Arnott, Bot. Beechey, p. 391 (1841); Hooker, Icon., t. 380 (1841); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 31, 89, fig. 8 (1857); Nuttall, Sylva, vol. 1, p. 21, t. 5 (1865); Bolander, Proc. Cal. Acad., vol. 3, p. 231 (1866); Engelmann, in Bot. Cal., vol. 2, p. 99 (1880); Kellogg, For. Trees Cal., p. 69 (1882); Hazard, Erythea, vol. 1, p. 159 (1893); Sargent, Silva N. Am., vol. 8, p. 183, t. 438 (1895); Jepson, Fl. W. Mid. Cal., p. 144 (1901).

Var. *echinoides* Sargent, Silva N. Am., vol. 8, p. 183 (1895). *Quercus echinoides* R. Br. Campst., Ann. & Mag. Nat. Hist., ser. 4, vol. 7, p. 251 (1871).

*Quercus echinacea* Torrey, Pac. R. Rep., vol. 4, pt. 5, p. 137, pl. 14 (1856).

Forest tree commonly 40 to 100 but frequently 150 feet high, the trunk 1 to 4 feet in diameter, clear of branches for 15 to 70 feet and running through to the summit of the cone-like crown; bark on young trunks white-mottled, on old trunks brown, red inside, smoothish on the surface or roughly checked into small plates; leaves oblong to elliptic-oblong, 2 to 5 inches long, 1 to 2 inches wide, densely whitish, tomentose when young, the lateral nerves parallel, very conspicuous on the under side and ending in the teeth of the margin or the

margin sometimes entire; catkins either wholly staminate or with a few pistillate flowers towards the base, erect, very tomentose, 2½ to 5 inches long, occurring singly in the axils of the leafy shoots of the season; or sometimes the catkin-bearing shoots of the season are several, short, subterminal and leafless, or nearly so, thus forming a cluster of 30 to 45 catkins; staminate flower containing about 10 stamens which are 3 or 4 times as long as the woolly usually 5-lobed calyx; pistillate flower with an inferior ovary and a few rudimentary stamens; acorns maturing in the second autumn; cup shallow or almost flat, ⅞ to 1⅛ inches in diameter, covered with narrowly linear or subulate spreading scales; nut oval, varying to subglobose or subcylindric, ¾ to 1¼ inches long, the shell densely tomentose within, at first finely tomentose without.

The Tan Oak inhabits mountain slopes and cañons from within a few feet above sea-level to altitudes of 4000 feet, and is distributed from the Umpqua River in southwestern Oregon to the South Coast Ranges of California and through the Sierra Nevada as far south as Devils Gulch, Mariposa County. In the Coast Ranges its distribution bears a very definite relation to the Redwood Belt. While found everywhere with the Redwood, it is most abundant and of largest size towards the summits and easterly slopes of the seaward Coast Range, forming with the Douglas Fir, Madroña and Oregon Oak a forest belt just inside the Redwood Belt. While everywhere mingled with other species, it is easily distinguished even in a general view of the forest by its light-colored foliage. In the South Coast Ranges it is abundant in the Santa Cruz and Santa Lucia mountains, particularly on the westerly slopes. The southernmost locality is represented by a small area on the northerly slope of the Santa Inez Range a short distance from the head of Tajeques Cañon and about thirty miles back of Santa Barbara.[52]

This species is very shade-tolerant and occurs in great abundance as a low bush or small tree in the dense Redwood and Douglas Fir forests. In its adult form it has two markedly distinct forms in the North Coast Ranges, dependent upon its association. In the open woods of the "Bald Hills" country it is a broad-headed round-topped tree, as shown in plate 7. Associated with Redwood or Douglas Fir, where it has had from the beginning of the stand an equal opportunity, it assumes the coniferous habit, becomes very narrow-crowned, and its axis persists through to the very summit of the crown. It is our only broad-leaved tree which does this and is thereby enabled to compete with Redwood and Douglas Fir. The longest axis measured by the author was one hundred and forty-three feet.

Throughout its range Tan Oak is exceedingly uniform in its botanical characteristics. As is often the case with forest trees, woodsmen recognize two

[52] Additional localities have recently been made known on the watersheds of the Santa Inez, Santa Barbara, and Matilija rivers. It occurs on Mt. Pinos, and at the head of Horn Cañon near Nordhoff, "which is probably its southern limit" (Sudworth, Trees of the Pacific Slope, p. 322).

forms of it, but these are probably of little significance botanically. Of the following forms, the second or varietal is by far the more important:

Forma **lanceolata** Jepson. Leaves lanceolate, entire or with few small teeth, 2½ to 3½ inches long.—Mendocino and Del Norte counties.

Var. **echinoides** Jepson. Scrub Tan Oak. Low or spreading shrub 1 to 10 feet high; leaves thick, entire, 1 to 2 inches long, ⅓ to ⅞ inches wide, the nerves often inconspicuous; acorns 1 to 4 in a place; cups very bur-like, the subulate or filiform scales recurving.—About Mt. Shasta, westward to the Klamath Range and through the Siskiyous to southwestern Oregon. It is abundant in the Shelley Creek region of Del Norte County.

The bark of Tan Oak furnishes the best tannage known for the production of heavy leathers and extensive tanning plants are among the leading manufactories in California. The bark industry, an exploitation of the forests of Tan Oak, has been steadily growing. In taking off the bark in the peeling season, May to July, the men work in pairs. By a process which is called ringing, the bark is cut through to the wood in a circle around the trunk at the ground and again four feet above the ground, and then removed. This is the first "rim." The tree is then cut down. One man goes ahead "ringing" every four feet and the second man follows taking off the successive "rims." Bark less than three-eighths or one-half inch in thickness is commonly not peeled. Climbing a tree to get off extra rims is called "cooning." Young trees are peeled standing. In this case the bark is taken off as high as it can be reached with the axe, a method which is called "jayhawking." Jayhawked trees live two seasons after removal of the bark. In the second season they commonly bear an exceptionally large crop of acorns and then die, a phenomenon aptly called by the woodsmen the "last kick" of the tree. Occasionally such trees may live on indefinitely.

Tan Oak produces abundantly by stump sprouts. As many as fifteen to two hundred sprouts arise from the stump of a peeled tree. Eventually several shoots gain the ascendency and in fifteen or twenty years there is formed about the old stump a circle of slender, pole-like trees. Sprouts may also be produced from the stumps peeled standing. This fact fully explains the great longevity, remarked above, which occasional trees display, as the roots are thus furnished with assimilated food for growth without making a demand on the crown.

Reproduction is also provided for by seed. Acorns germinate readily in open spots in the forest where a great tree has fallen and permitted the entrance of sunshine. Seedlings are in fact a rarity because of too dense shade and the deep litter of undecayed twigs and leaves. Dry unprotected slopes are likewise discouraging to germination and especially trying to the vitality of the seedling in the rainless season.

The wood is close-grained, hard and strong, and is highly valuable if taken care of when cut and subjected to proper treatment. It has been successfully

used for furniture, interior finishing and in wagon-making. The peeled logs which are left in the forest fully exposed to the heat of the summer sun crack badly and soon rot. The great majority of peeled trees are abandoned in the forest to decay in this manner or be consumed by the first forest fire. At the present time (1907) the tanbark harvest totals about 25,000 cords annually. To produce this amount of tanbark requires the peeling of 100,000 trees. As a consequence 100,000 trunks varying in length from 10 to 100 feet or more and ½ to 4 feet in diameter are totally sacrificed, so far as the wood is concerned, saving a small percentage, perhaps about five per cent., which is cut into firewood. It is only in a few of the more accessible districts that the logs are sawn into four-foot cordwood and shipped to the larger cities to be used for fuel, for which it has a high value.

Acorns are produced in great abundance and in Mendocino and Humboldt counties were used in former days in bread-making by the native tribes, and this oak is therefore locally known as "Squaw Oak." The kernels were ground into a meal, which was put into a basin of sand and washed with hot water to expel the bitter principle of the acorn, finally being cooked as mush or made into bread. Even at this day white men may sometimes see Indian women leeching acorn meal in the sands of the Trinity River.

The Tan Oak is of great biological as well as economic interest. While commonly called Tan Oak it is sometimes called Burr Oak and frequently Chestnut Oak by woodsmen who recognize its relationship to both the oaks and the chestnuts. It is an aggressive tree and exceptionally well-fitted by its reproductive powers, vigor and shade-endurance to take part in the struggle for continuous possession of the land which it occupies. Recognition of its capacities in this direction finds expression in the folk-name, Sovereign Oak.

### 3. Castanopsis Spach. Chinquapin.

Trees or shrubs with evergreen leaves and branchlets lengthening by a terminal bud. Catkins erect. Staminate flowers in clusters of 3, disposed on elongated, sometimes branching catkins; calyx 5 or 6-parted; stamens 10 or 12; ovary rudiment present. Pistillate flowers 1 to 3 in an involucre, the involucres on shorter catkins or sometimes scattered at the base of the staminate catkin; calyx 6-cleft with abortive stamens on its lobes; ovary 3-celled with 2 ovules in each cell; styles 3. Fruit maturing in the second season, the spiny involucre enclosing 1 to 3 nuts. Nuts ovoid or globose, more or less angled, usually 1-seeded.—Two species on the Pacific Coast of North America and about twenty-five in southeastern Asia.

Key to the Species.

Tree with abruptly long-pointed leaves; staminate catkins often branching .....1. *C. chrysophylla.*
Shrub with smaller obtuse or merely acute leaves; staminate catkins simple ....2. *C. sempervirens.*

## 1. Castanopsis chrysophylla A. DC.

GIANT CHINQUAPIN.

Plate 74.

CASTANOPSIS CHRYSOPHYLLA A. DeCandolle in Seeman's Jour. Bot., vol. 1, p. 182 (1863), Prodr., vol. 16, pt. 2, p. 109 (1864); Watson, Bot. King, p. 322 (1871); Torrey, Bot. Wilkes, p. 463 (1874); Watson, Bot. Cal., vol. 2, p. 100 (1880) in part; Kellogg, For. Trees Cal., p. 76 (1882); Sargent, Silva N. Am., vol. 9, p. 3, t. 439 (1896) in part.

Var. MINOR A. DeCandolle, Prodr., vol. 16, pt. 2, p. 110 (1864).

*Castanea chrysophylla* Douglas, in Hook. Fl. Bor. Am., vol. 2, p. 159 (1853), Comp. Bot. Mag., vol. 2, p. 127 (1836); Hooker, Lond. Jour. Bot., vol. 2, p. 496, t. 16 (1842), Bot. Mag., vol. 82, t. 4953 (1856); Nuttall, Sylva, vol. 1, p. 37 (1865); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 26, 89, figs. (1857); Kellogg, Proc. Cal. Acad., vol. 4, p. 280 (1872); Bolander, Proc. Cal. Acad., vol. 3, p. 231 (1866) as to Mendocino Plains plants; Jepson, Fl. W. Mid. Cal., p. 145 (1901) in part. Var. *minor* Bentham, Pl. Hartw., p. 337 (1857).

In most well-developed form a forest tree 50 to 115 feet high, the unbranched shaft clear of branches for about one-half its height; branches short, forming a narrow crown rounded at summit or in age more or less broken; trunk 2 to 6 feet in diameter and protected by a fibrous bark 3 inches thick; bark reddish, but brown or dull gray on the surface and separated by deep furrows into heavy rounded ridges which are sparingly confluent; or most commonly met with as a younger or smaller tree 15 to 50 feet high with pointed top and smooth gray bark; leaves oblong, tapering to base and also to the apex (which is often abruptly long-pointed), entire, dark green on the upper surface, at first golden with a fine tomentum below, later light olive-yellow, 2½ to 5½ inches long, ¾ to 1¾ inches wide, nerves straightish, forking well inside the margin; flowers in erect slender catkins borne in more or less panicled clusters at the ends of the branches; staminate catkins simple or branching, 1 to 4 inches long, the flowers in clusters of 3 to 5, subtended by minute bracts; stamens 6 to 10, much surpassing the calyx; pistillate flowers 1 to 3 in each involucre, the involucres borne in shorter catkins or sometimes scattered at the base of the staminate catkin, ripening the second autumn into burs; burs spiny, chestnut-like, irregularly 4-valved, containing 1 or sometimes 2 subtriangular nuts 4 or 5 lines long with hard shell and sweet kernel.

The Giant Chinquapin, sometimes called Gold-leaf Chinquapin or California Chestnut, inhabits mountain slopes and is distributed from the outer Coast Ranges of Mendocino County to the high ridges of northwestern Siskiyou, thence northward along the Cascades to the Columbia River. As a forest tree it reaches its greatest size in the moist Redwood belt of Mendocino County, where individuals seventy-five to ninety-five feet in height, with trunks forty to fifty-five feet high and three to four feet in diameter, are found. With straight, clear trunks rising to narrow crowns, these splendid trees represent

one of the most remarkable species of the California woods. There are not many of these mature trees. Scattered through the forest like giant sentinels I saw one here and one there at long intervals or at most in little clusters and always mingled with Redwood, Tan Oak, Douglas Fir or Madroña. I have always found them on the ridges. Fine examples may still be seen near Willits, Jackson Valley, and Sherwood. In the yard of the Hawley School, one mile from Willits on the Sherwood Valley road, is a tree one hundred or possibly one hundred and fifteen feet high and four feet four inches in diameter at five feet above the ground.[53] Another tree is six feet in diameter at four feet above the ground. Kellogg, who lived at times for weeks in the Mendocino forest, writes of trees one hundred to one hundred and fifty feet high and five to nearly ten feet in trunk diameter. I have never seen trees whose size at all approximated the larger figures.

*Castanopsis chrysophylla* in its most ordinary form occurs as a small tree up to fifty feet high. Small trees are not only more frequent than the giant forms first described but, moreover, may form colonies. There is a fine grove on the seaward slope, in a north hollow, up-grade to Kenny from French's, northwestern Mendocino County, the trunks recalling in smoothness and color young Tan Oak trunks. Yet again and very frequently this species occurs as a shrub which has been given a varietal name:

Var. **minor** A. DC. Golden Chinquapin. Shrub 2 to 12 feet high; leaves 2 to 3 inches long, very golden beneath, often slightly trough-shaped above; catkins profuse.—Santa Cruz Mountains and northward, often more or less gregarious on chaparral slopes and on the pine barrens of the Mendocino coast.

It passes into the ordinary arboreous form as may be noted on the higher ridges about Salmon Summit, where there are numerous low spreading bushes, three or four feet high, simulating typical *Castanopsis sempervirens.* As one descends the Salmon River trail one may note every gradation to the arboreous forms on the lower ridges,—the central part of the low broad bush getting a little higher, becoming a sapling, then more or less tree-like, finally a tree up to fifty feet high, whose trunk has not the smooth gray bark of the bush and sapling, but is clothed in the dark brown furrowed bark characteristic of the arboreous type.

The wood is soft but hard when seasoned, close and straight-grained, with white and reddish brown heart-wood, taking a glossy finish. While the wood is valuable the trees do not occur in sufficient quantity to engage the present-day interest of the logging companies, although the trees are frequently cut for fuel. The bark parts very readily from the wood and is often mixed with the com-

[53] The Hawley School is now moved from this spot and these trees will probably be destroyed in the logging of the surrounding forest.

mercial bark of the Tan Oak, the fine logs being left to rot on the ground. It was with a lively sense of protest that I learned that the hide of this tree, called by the woodsmen "Red Oak," went into the tanbark cords indifferently with Tan Oak bark. This practice is all the more reprehensible in that the bark has no value for tanning purposes. Fortunately on account of its tough fibre it injures the smaller tan-bark grinding mills and the buyers frequently make firm objections if they detect the adulteration.

*Castanopsis chrysophylla* is a rare tree in the North Coast Ranges and Cascades as compared with its associated species, a fact undoubtedly due to its weak seed production. It fruits very sparingly and good nuts are difficult to obtain. It was first collected by David Douglas while on a journey from the Columbia River to the Umpqua River in 1826. He also noticed the rarity of the fruit.

2. **Castanopsis sempervirens** Dudley. Bush Chinquapin. (Plate 75.) Spreading shrub 1 to 8 feet high with smooth brown bark; leaves oblong, acutish at base, acute or obtuse at apex, or sometimes tapering upwards from near the base and therefore lanceolate-oblong, 1½ to 3 inches long and 5 to 11 lines broad; catkins simple, 5 to 20 in a rather dense terminal cluster, 1 to 1½ inches long, the upper with pistillate flowers at the base; stamens varying from 10 to 17, rarely as few as 8; styles 3, light brown, clavate.

The Bush Chinquapin grows on arid mountain slopes and ridges from the summits of Mt. San Jacinto northward through the Sierra Nevada and Coast Ranges to Mt. Shasta at 3000 to 8000 feet elevation. As a low spreading bush with thin whitish or gray smooth bark it is widely different from the adult form of the Giant Chinquapin, a tree eighty feet high with a heavily furrowed bark three inches thick. Yet in these particulars the Bush Chinquapin differs no more from the Giant Chinquapin than does the young state of the latter, var. *minor,* which on account of its habitat may be permanently dwarfed.[54] Typically Bush Chinquapin has blunt leaves relatively less broad than in Giant Chinquapin, which is marked by its abruptly long acute leaves. The leaves of the former are plane, with a pale yellow or greenish powdery pubescence beneath; the leaves in var. *minor* are more or less trough-like (with the sides of the leaf semi-conduplicate) and curving, and with a bright golden powdery pubescence which is more permanent. The catkins of Bush Chinquapin are simple, those of the Giant Chinquapin simple or branching in leafless panicles two to six inches long. I perceive no differences in the fruits. The kernels in Giant Chinquapin are said to be sweeter than Bush Chinquapin.

[54] *Castanopsis chrysophylla* var. *minor* occurs in the chaparral on the southwesterly slope of the Pt. Pinos ridge at Monterey and on the summit of Moraga Ridge in Contra Costa County as a low spreading dwarf-like bush, not in the least different in habit from the usual form of *Castanopsis sempervirens.* It still retains, however, its distinctive leaves, both as to shape and other characteristics.

## LAURACEAE. Laurel Family.

Aromatic evergreen trees and shrubs. Leaves alternate, simple, entire, without stipules. Flowers perfect and regular. Petals none. Anthers opening by uplifted valves. Ovary superior, 1-celled, 1-ovuled, with a single style. Fruit in ours a drupe.—A large family, chiefly tropical, including the Cinnamon, Camphor, Sassafras, Alligator Pear or Avocado, and the Bay Laurel of the ancients.

### Umbellularia Nutt.

Flowers in simple peduncled umbels. Sepals 6. Stamens 9, the inner three with a stipitate orange-colored gland on each side of the filament at base and alternating with scale-like staminodia; anthers 4-celled, 4-valved, the three inner extrorse, the outer introrse.—Only one species.

### 1. **Umbellularia californica** Nutt.

California Laurel.

Plate 76; plate 10.

Umbellularia californica Nuttall, Sylva, vol. 1, p. 87 (1842); Kellogg, For. Trees Cal., p. 110 (1882); Parish, Zoe, vol. 4, p. 344 (1894); Wright, Erythea, vol. 3, p. 97 (1895); Sargent, Silva, N. Am., vol. 7, p. 21, t. 306 (1895); Jepson, Fl. W. Mid. Cal., p. 191 (1901); Chesnut, Contrib. U. S. Nat. Herb., vol. 7, p. 349 (1902); Power and Lees, Trans. Chem. Soc. Lond., 1904, p. 629.

*Tetranthera californica* Hooker & Arnott, Bot. Beech., p. 159 (1833).

*Laurus regia* Douglas, Comp. Bot. Mag., vol. 2, p. 127 (1836).

*Oreodaphne californica* Nees, Sys. Lau., p. 463 (1836); Newberry, Pac. R. Rep., vol. 6, pt. 3. p. 24, fig. 3 (1857); Hooker, Bot. Mag., t. 5320 (1862).

*Drimophyllum pauciflorum* Nuttall, Sylva, vol. 1, p. 85, pl. 22 (1842).

Tree commonly 20 to 75 feet high with a dense crown of long and upright slender branches; bark drab or brown, thin (mostly ¼ to ½ inch thick); leaves aromatic, thickish, entire, 3½ to 4½ inches long, ¾ to 1 inch broad, tapering rather more to apex than to base and borne on short petioles; umbels 4 to 9-flowered, but setting only 1 to 3 (or rarely 6) fruits; flowers small (2 lines long), yellowish green; drupe greenish or when ripe reddish or brown-purple, 1 to 1¼ inches long; seed without endosperm, the embryo with two large thick cotyledons and a short caulicle.

The California Laurel inhabits the Coast Ranges from the Umpqua River in Oregon to Southern California and is also found on the western slope of the Sierra Nevada. In the North Coast Ranges it occurs from sea-level to 4000 feet

altitude. In the Sierra Nevada it ranges as high as 4000 feet (Yosemite Valley) or to 5000 feet (Kaweah Basin), but is less common than in the Coast Ranges. In Southern California it is found on the southern slopes of the San Bernardino Mountains from 2000 to 2500 feet, on the west slope of San Jacinto below 5000 feet, and in Oriflamme Cañon, near Julian. The latter is the most southerly locality yet noted.

Such geographical data, however, give no true measure of its status in this region. While rarely abundant, no broad-leaved tree in California has adapted itself to so great a variety of situations. In the Coast Ranges it grows in valleys, on alluvial flats, on sea-bluffs, in sharp deep cañons, on fertile hill slopes, on rock cairns and on sun-burnt ridges in the mountains. These various habitats have given rise to as many ecological forms, which may be described as follows:

*Typical form.* This, the most common form in middle California, is aboreous; forty to seventy-five feet high, and usually taller than broad. It has erect branchlets and is found along streams, either in the cañons, at the edges of the valleys where the streams come out of the hills, or on valley floors.

*Pendulous form.* This form is not in the least common, but observant travelers will occasionally find trees on alluvial flats or choice spots in the hills which attract the eye by their different habit and hang of foliage. They are large, spreading trees, whose crowns are broader than the tree is tall and whose branchlets are drooping. Good types of this form flourish in the deep soil of the hills about Olema in Marin County and elsewhere northward.

*Gregarious form.* This is gregarious on northerly slopes of cañons. In typical colonies of this sort nothing but Laurel is found and the individual trees quite lose character. All the plants are of the same height and grow very thickly together. A remarkable example, locally celebrated as "Laurel Hill," is to be found at Inverness, Point Reyes Peninsula, on the north slope of the "First Valley," where there is a dense thicket a quarter of a mile long. The top of it is even and close as if clipped. This even surface results from the exceedingly high winds which blow in from the ocean through the mouth of Tomales Bay. From the top of the opposite hill one may see its smooth green surface broken here and there by little rifts, which suggest eroding rivulets. In several places clumps are cut off vertically, sharp and clean, as if with a scythe, a phenomenon caused by the dying out of small areas or a cluster of individuals in the colony. Viewed from a distance the thicket seems to be four or five feet in height, but if one explore it the trees lowest on the hillside are discovered to be as much as forty feet in height. Higher up the hill they decrease to twenty-five feet and at the very summit are as low as fifteen feet. The trunks are long and slender, set very thickly, scarcely over three inches in diameter and each with a broom-

like top. On the higher parts of the hill they are somewhat segregated in clusters which take a more or less circular form. A similar colony may also be found near the bottom of the sharp cañon between Fish Ranch and Bryant, Contra Costa County. The gregarious form is confined to cañon walls, where the soil and moisture conditions are favorable and where the wind currents are contracted as in a funnel.

*Rockpile form.* A small tree or bush 10 to 15 feet high growing on rockpiles and represented by isolated individuals. The trees of deep cañons, following the ramifications of water-courses up hill, become smaller and smaller until at the very beginning of hill streams they are mere bushes. They show little liking for parched gulches and avoid the open hillsides, but reappear higher up on the ridges or flanking spurs, crowning the highest points of outcropping ledges or cairns. These compact, isolated trees or cluster of sprouts take advantage of the broken strata to work their roots down to water and form very characteristic knobs or bunches in such barren places as the Berkeley Hills.

*Dwarf form.* In the higher parts of the Coast Ranges one frequently finds the laurel three to six feet high with narrow crowns and pointed tops scattered among the shrubs of the chaparral. The hard conditions of chaparral slopes cause a reduction in the stature and size of leaf, but otherwise the individuals are laurel trees in miniature. Notwithstanding this reduction it is still rather conspicuous in such company because unlike other species of the chaparral its pointed tops rise above its associates. This form is usually dense headed and fruits very heavily. Good examples of it are to be found in the Vaca Mountains, on the westerly slopes of Howell Mountain, and on Twin Sisters Peak.

*Prostrate form.* This type is littoral and illustrates the great versatility of the species; it inhabits steep hillsides or bluffs fronting the ocean, where it forms low green mats one or two feet high and ten to fifteen feet in diameter surfaced as smooth by the wind as a well-kept lawn. Excellent examples of this state are to be seen at Greenwood on the southern Mendocino coast.

The largest sized laurel trees in California are confined to the "Redwood Belt." The finest ones in the Bay Region grow in the lower part of Bear Valley, Point Reyes Peninsula, on the Shafter Ranch, where there are many fine trees. The largest sized groves are, however, to be found only on the alluvial benches of Eel River and other streams northward. In point of size and number of trees no groves in California equal those on the Eel River at Camp Grant and at Pepperwood. These areas contain only Laurels, which are seventy to one hundred or one hundred and twenty-five feet high. Their trunks are very erect, straight and slender, the largest-sized ones being three feet to six feet and six inches in diameter at four feet above the ground. On the journey

to the Humboldt coast from the Blocksburg region one travels through the deep shade of these groves for several miles. There is little level land in this country and several hundred acres of this strip have been cleared by felling and burning to make place for hay fields.

The largest California Laurel known to the writer grows near the town of Cloverdale. It is situated in a field of the fertile, low-lying lands on the east side of the Russian River and about four hundred yards northeast of the bridge spanning that stream. This tree is an isolated individual standing on a fence line. From its size and port one at a distance might easily mistake it for a Valley Oak and yet the critical traveler would say it could not be of that species. As one approaches it, the eye is more and more impressed with its stately character. The crown is very broad, indeed almost globular in outline, and its branchlets are drooping. These features, as well as the habitat, suggest superficial resemblance to the Valley Oak. The crown is ninety-three feet and six inches in longest diameter and its height is about seventy-five feet. The trunk is fourteen feet and seven inches in circumference at five feet from the ground; near the base it flares very considerably, so much so that it may be called table-like, and measures twenty-nine feet in circumference at the ground. Above the tabular base the trunk is very columnar and does not lose, appreciably, in girth before branching, and is, in a word, very symmetrical. Fortunately it has not been injured by cuts, "blazes," or spikes and is, like the whole tree, in a healthy condition (plate 76).[55]

Unless persistently attacked by man, reproduction in the Laurel is amply provided for, since it stump-sprouts freely when felled by the axe or thrown down by the wind, while quantities of fertile seeds are produced each year. Commonly large numbers of sprouts form a circle about the base of the parent stump, and while only a few of these survive and form poles or trees the evidence of their origin is usually clear. The vitality of the tree is further evidenced by the large number of shoots which arise along the trunk when the tree is thrown down, but not wholly uprooted, and is particularly striking where a Laurel tree has been thrown across a stream.

The seeds are so large that they are not readily buried or planted naturally. Ground squirrels probably store the seeds. Seedling growth in the drier parts of California is not common, but in protected areas or where there is some disturbance of the ground sufficient to cover the seeds, seedlings easily establish themselves.

*Umbellularia californica* was first collected by Archibald Menzies in California in the latter part of the eighteenth century, but long before the days of Menzies and the Vancouver expedition the Spanish Californians knew the tree and called it *Laurel silvestre*. Nowadays it has many common names. Best of

[55] Cf. Cloverdale Reveille, December 26, 1903.

all California Laurel, it is also called Mountain Laurel and Oregon Laurel, while its aromatic foliage explains the names Bay Tree, Bay Laurel, Spice Tree and Pepperwood. By the last name the tree is best known everywhere in the woods of Sonoma, Mendocino and Humboldt. In Oregon it is most commonly known as "Myrtle" or "Oregon Myrtle." Cajeput, the Malay name of Melaleuca trees of the East Indian Islands, has been senselessly transferred to the California tree, but should be dropped.

Its wood is heavy, hard, and strong, and takes a high polish. In manufacturing it is used for turned articles and is especially valued for furniture and interior finish. For these latter purposes no other Pacific Coast wood furnishes such luxurious patterns. In early days when oxen were used in logging, it was chosen to make ox-yokes and was used by the lumber companies for rails on logging roads. It has also been employed for staves and for shoe-lasts. On the Coquille River in Oregon the lumbermen distinguish two forms which they call "Yellow Myrtle" and "White Myrtle." The foliage of "Yellow Myrtle" is yellowish; its wood is richer in oil and has a stronger odor, is easier to split or cut, is more durable, and in age becomes streaked with black. The foliage of "White Myrtle," which is the more abundant form, is dark green with a bloom on the lower face; its wood is harder, more brittle, difficult to split and decays rapidly when left lying on the ground. The "Black Myrtle" of the millmen is produced by sinking logs in water to improve the color of the wood.

Hogs feed upon the nuts and grow fat when the crop is abundant, but the meat has a peculiar taint. The native tribes roasted the nuts and used them for food, but apparently did not eat great quantities at one time, using them rather as a stimulant or condiment. As prepared by the Indian they are not merely edible, but as sweet as chestnuts. A decoction of the leaves they also used in medicine, according to V. K. Chesnut, and as an insecticide.

The leaves may persist four or five years. As they are alternate and scattered they set far back on the branches and the crown is thus more densely foliaged than is any other Californian tree, a fact which explains the overthrowing of trees, so frequently observed after severe north or especially southeast wind and rain storms. The flowers attract little notice and the fruit while on the tree scarcely more. The former are inconspicuous and greenish yellow and appear in small clusters at the ends of the branches in December or January, or sometimes as late as the first half of March. They produce rather large fruits which are not ripened until a year later. It is in the middle of the winter that the fruits fall and cover the ground as if with a shower of large purple olives, so much do they resemble the drupes of the olive tree.

## PLATANACEAE. Plane-tree Family.

Large trees with alternate ample palmately lobed leaves and sheathing stipules; dilated base of petiole enclosing the bud of the next season; bark falling away in thin plates. Flowers monoecious, the staminate and the pistillate on separate axes, closely packed on a receptacle in separate ball-like clusters which are distributed at intervals along a terminal very slender axis, the inflorescence thus appearing moniliform. Receptacles very hairy and individual flowers difficult to segregate, the staminate probably of 3 or 4 stamens and the pistillate of 6 to 9 pistils.[56] Sepals or petals none. Stamens with long anthers and very short filaments densely crowded on a globose fleshy receptacle. Pistils with interspersed clavate truncate bracts, crowded on a similar receptacle; ovary 1-ovuled; style one, filiform, laterally stigmatic. Fruit a coriaceous nutlet with tawny hairs about the base.

### 1. Platanus L. Plane-tree.

The only genus. About four species and five varieties. The Old World Plane, *Platanus orientalis,* is cultivated as a street tree.

### 1. **Platanus racemosa** Nutt.

Western Sycamore.

Plates 77, 78.

Platanus racemosa Nuttall, Sylva, vol. 1, p. 47, t. 15 (1842); Newberry, Pac. R. Rep., vol. 6, pt. 3, p. 33, pl. 2 and fig. 10 (1857); Watson, Bot. Cal., vol. 2, p. 66 (1880); Kellogg, For. Trees Cal., p. 94 (1882); Coville, Bot. Death Val. Exped., p. 195 (1893); Parish, Zoe, vol. 4, p. 344 (1894); Sargent, Silva N. Am., vol. 7, p. 105, t. 328 (1895); Jepson, Fl. W. Mid. Cal., p. 275 (1901).

*Platanus mexicana* Torrey, Pac. R. Rep., vol. 7, pt. 3, p. 20 (1856), not Moricand.

*Platanus californica* Bentham, Bot. Voy. Sulphur, p. 54 (1844).

Tree 40 to 90 feet high, typically with huge wide-spreading limbs from a leaning, horizontal, or even prostrate trunk 1 to 5 feet in diameter; bark smooth but exfoliating thin reddish brown plates exposing greenish areas in turn; leaves commonly broader than long, 4 to 12 (or 20) inches broad, 3½ to 9 (or 13) inches long, parted into 3 to 5 broad spreading lobes, the lower pair often smaller or reduced to mere teeth, the under side pubescent or in age rusty with star-shaped hairs; margin entire or with scattered small and blunt cusps terminating the main veins; petioles ½ to 1¾ inches long, the expanded base

[56] Griggs, Bull. Torr. Club, vol. 36, p. 390 (1909).

covering the bud of the next season; stipules very conspicuous when full grown, roundish or angular in outline and encircling or sheathing the stem; ball-like flower clusters 2 to 5 or 7 in number, distributed at intervals along a pendulous and very slender axis borne at or near the end of a branch; pistillate balls ¾ to 1¼ inches in diameter when mature, falling to pieces in the winter, releasing the seed-like nutlets.

The Western Sycamore (or Plane-tree) commonly inhabits the beds and alluvial benches of creeks and streams in the valleys and often follows cañon bottoms into the mountains. It grows in the valley of the Sacramento on the banks of the Sacramento River and its main arms, marches along the San Joaquin River and ascends its upper eastern tributaries into the foothills of the southern Sierra Nevada as high as 4000 feet, thence ranging southwesterly through the coastal region of Southern California to Lower California.

It is found throughout the South Coast Ranges, where it is one of the most widely distributed arboreous species. It grows about Mt. Diablo, passes through the Mt. Hamilton Range southward, extends westward to Wildcat Creek and the eastern slope of the Berkeley Hills, crosses the divide to San Leandro Creek, is abundant in the Niles Cañon and Santa Clara Valley, ascends the eastern slope of the Santa Cruz Mountains in cañons to 800 feet altitude, and is a common tree in the valleys southward. There are many fine trees in Stephens Creek cañon southwest of Palo Alto, also along Arroyo Grande, near San Luis Obispo, and in the beautiful Sycamore Cañon, near Santa Barbara. It often fills the washes opening to the sea in western San Diego County; it is common through all the cismontane country eastward to Cuyamaca and Palomar mountains, and northeastward to the San Jacinto and San Bernardino valleys; it ascends San Jacinto and San Bernardino and Sierra Madre mountains to about 3000 feet, where it is associated at its uppermost limits with Yellow Pine stragglers from the main belt above.

The Sycamore reaches its greatest development as a tenant of river beds in low valleys of 10 to 800 feet altitude, so that the stream-bed habitat and the very irregular crown with divided, leaning, or trailing trunks are associated characteristics. While infrequent on mountain sides it there takes on a different form. In a wet swale near Dani, west slope of the Santa Lucia Mountains, I saw a small grove of Sycamores, tall, slender unbranched trees, seventy to ninety feet high, the trunks very straight and recalling alder trunks. They occupy about one acre.

The distribution of our Sycamore has features of interest. Its region is semi-arid, characterized by a moderate rainfall (rarely exceeding 10 to 20 inches), by long dry summers (with maximum temperatures of 80° to 120° F.), and by moderate temperatures in winters (minimums of 21° to 40° F.). Its favorite habitat in the beds or on benches of flood streams is practically identical with

that of Common Cottonwood, but it is confined to narrower geographical limits. Fremont or Common Cottonwood is frequent on the desert and also enters the humid North Coast Range area. The Sycamore shuns the strictly desert country, being found nowhere on the Mohave or Colorado deserts nor eastern side of the Sierra Nevada mountains. On the other hand it avoids too moist country and I have never seen a tree in the North Coast Ranges, nor even on the western side of the Sacramento Valley.[57] Curiously enough Sycamore is associated with Redwood in the river beds of the Little Sur and Big Sur and in many other cañons on the west slope of the Santa Lucia Mountains. I have never found Common Cottonwood associated with Redwood, although both these species are found on the upper reaches of the Russian River between Cloverdale and Ukiah.

*Platanus racemosa* was first collected by Thomas Nuttall at Santa Barbara in 1835. The most southerly reported locality is Mt. San Pedro Martir in Lower California. The most northerly locality is on the Sacramento River at Anderson, Shasta County. The finest tree I have measured is a symmetrical individual on the river bench of the Santa Ana River at Riverside; it is eighty feet high with a perfect trunk five feet in diameter at four feet above the ground.

The wood rots quickly in contact with soil; it is light and soft, but exceedingly compact and complex in its grain and very difficult to split, but if quartered in sawing furnishes a grain of beautiful design for furniture. It has been used for wooden buttons, whence the name "Buttonwood Tree." Sir Edward Belcher of the British ship *Sulphur,* while exploring the Rio Sacramento in 1837, made use of the wood, which he found good for "gunwales and timbers for light boats."

It is often, especially in Southern California, the only tree in its locality and its trunk is inclined to diverge widely from the perpendicular on account of the unstable character of alluvial benches and sand bars in river bottoms. On account of its large irregular top, the long reach of its branches, its ample foliage, turning bronze-color in late autumn, its handsome strings of balls, flaky, light-gray bark and the characteristic country which it favors, it holds the attention of the traveler and takes a permanent place in his interest.

## ROSACEAE. Rose Family.

Herbs, shrubs or trees with alternate leaves and persistent stipules. Flowers perfect, perigynous or epigynous. Calyx 5-lobed. Petals 5, rarely none. Stamens generally 10 to numerous, inserted with the petals on the margin of the disk lining the calyx-tube. Pistils 1 to many, distinct and free from the calyx, 1-celled with one style and stigma, or united into a 2 to 5-celled ovary, which is partly or completely inferior; styles as many as the carpels. Fruit a

[57] It should be looked for along foothill streams on the east side of the inner Coast Range.

follicle, an achene, a drupe, a cluster of drupelets (as in a blackberry), or a pome. Seeds with straight embryo; endosperm usually none.—A large and variable order, furnishing many of the cultivated plants of garden and orchard.

KEY TO THE GENERA.

Leaves alternate, simple.
  Ovary superior.
    Fruit an achene; flowers small, without petals ..... 1. CERCOCARPUS.
    Fruit a drupe; flowers with petals ..... 2. PRUNUS.
  Ovary inferior; fruit a pome; flowers with petals ..... 3. PYRUS.
Leaves opposite, pinnately divided, remarkably fern-like; ovary superior ..... 4. LYONOTHAMNUS.

## 1. CERCOCARPUS H.B.K. MOUNTAIN MAHOGANY.

Deciduous shrubs or low trees with spur-like branchlets and simple coriaceous straight-veined leaves. Flowers from winter buds, solitary or fascicled, terminal on the short branchlets. Calyx consisting of a slender pedicel-like tube abruptly expanded into the low-hemispherical deciduous 5-toothed limb. Petals none. Stamens numerous, borne in two or three rows on the calyx. Pistil 1, with a 1-celled ovary, 1 ovule and a single long style and terminal stigma. Fruit a villous achene enclosed in the persistent calyx-tube and surmounted by the very much elongated twisted soft-hairy style.—About three species, Mexico and Pacific Coast of the United States.

KEY TO THE SPECIES.

Flowers solitary or rarely in pairs; leaves narrowly lanceolate ..... 1. *C. ledifolius.*
Flowers in 2- to 5-flowered clusters.
  Leaves obovate, cuneate at base; clusters 2- to 3-flowered ..... 2. *C. parvifolius.*
  Leaves ovate to elliptic; clusters 4- to 5-flowered ..... 3. *C. Traskiae.*

### 1. **Cercocarpus ledifolius** Nutt.

DESERT MAHOGANY.

CERCOCARPUS LEDIFOLIUS Nuttall, in Torr. & Gr., Fl. N. Am., vol. 1, p. 427 (1840); Nuttall, Sylva, vol. 1, p. 178, pl. 51 (1865); Brewer & Watson, Bot. Cal., vol. 1, p. 174 (1876); Sargent, Silva N. Am., vol. 4, p. 63, t. 165 (1892).

A shrub or scraggy tree, usually 6 to 20 or sometimes 40 feet high, with a short trunk, ½ to 1 or rarely 2 feet in diameter; leaves narrowly lanceolate, acute at both ends, entire with revolute margins, coriaceous, pale or rusty pubescent below, becoming glabrous and lustrous above, somewhat resinous, ½ to 1 inch long with a prominent midrib; flowers sessile; calyx-limb deeply toothed; calyx-tube in fruit 4 or 5 lines long, the achene 3 lines long, and its tail 2 or 3 inches long.

The Desert Mahogany is widely distributed in the region between the Rocky Mountains and the Sierra Nevada and Cascade ranges, at altitudes of 5000 to 9000 feet. In California it is most common on the eastern slope of the Sierra Nevada. It also occurs from the Kaweah Basin southward to the San Bernardino Mountains and Mt. Pinos, and in the North Coast Ranges from Snow Mountain to the easterly spurs of the Scott Mountains overlooking Shasta Valley. On Mt. Pinos, where trees have been measured by H. M. Hall, it occurs between 5800 and 7500 feet, as follows: at the mouth of North Fork Cañon are many good-sized trees, one twenty-two feet high with seven branches from base, the largest one foot and six inches in diameter; between North and Middle forks[58] is a large tree twenty-four feet high with main trunk two feet two inches in diameter; between Bitter Creek and Middle Fork are symmetrical trees with regular spreading branches, the trunks twisted but straight. It is also found back of Santa Barbara (Mrs. K. Brandegee).

2. **Cercocarpus parvifolius** Nutt. Mountain Mahogany. Shrub; leaves obovate, serrate above the middle, cuneate and entire towards base; clusters 2- to 3-flowered.—Common chaparral shrub throughout the Coast Ranges and Sierra Nevada. Sometimes called Hard-Tack by the mountaineers, the dry wood so hard that "common nails cannot be driven into it."

3. **Cercocarpus Traskiae** Eastw. Leaves oval to semi-orbicular; flowers 4 to 5 in a cluster.—South side of Catalina Island, *Mrs. Blanche Trask*. A very interesting small tree or shrub, remarkable for its very local habitat. Young plants are now growing in the botanic garden of the University of California and may avert its threatened extinction.

## 2. Prunus L. Plum.

Shrubs or small trees. Leaves simple, serrate. Flowers white, in corymbs or in racemes from lateral buds borne on wood of the previous season, appearing before or with the leaves. Petals 5. Calyx 5-cleft, deciduous after flowering. Stamens 15 to 30. Pistil 1; style terminal. Drupe globose, without bloom; flesh sweet or bitter; stone globose or compressed, bony.—About one hundred and twenty species, twenty-five in the United States.

### Key to the Species.

Leaves conduplicate in bud; drupe globose.—Cerasus.
- Flowers in corymbs; drupe small, bright-red ..... 1. *P. emarginata.*
- Flowers in racemes
  - Peduncle leafy; drupe small, its flesh astringent; foliage deciduous ..... 2. *P. demissa.*
  - Peduncle leafless; drupe large, its flesh sweetish; foliage evergreen ..... 3. *P. ilicifolia.*

Leaves convolute in bud; drupe oblong, ¾ to 1 inch long.—Prunophora.
- Flowers in umbels ..... 4. *P. subcordata.*

[58] These local names refer to forks of Lockwood Creek.

### 1. **Prunus emarginata** Walp.

BITTER CHERRY.

PRUNUS EMARGINATA Walpers, Rep., vol. 2, p. 9 (1843); Brewer & Watson in Bot. Cal., vol. i, p. 167 (1876); Sargent, Silva N. Am., vol. 4, p. 37, t. 157 (1892).

*Cerasus emarginata* Douglas in Hooker, Fl. Bor. Am., vol. i, p. 169 (1839); Jepson, Fl. W. Mid. Cal., p. 285 (1901).

*Cerasus glandulosus* Kellogg, Proc. Cal. Acad., vol. i, p. 59 (1855).

Deciduous shrub 3 to 8 feet high, or rarely a tree 20 feet high, with smooth dull red bark; leaves ovate or more commonly oblong-obovate, mostly obtuse, finely serrulate, ¾ to 1½ inches long, on petioles 1 to 3 lines long; blade with 1 or 2 glands just above junction, with petiole; flowers 3 to 10 in short corymbs; drupe 4 or 5 lines long, bright red, the pulp intensely bitter.

The Bitter Cherry is distributed from Southern California northward to British Columbia. It is abundant in the Sierra Nevada and high Coast Ranges between 4000 and 8000 feet where it forms extensive shrubby thickets. At lower elevations, as in Southern California and on the Truckee River, it sometimes becomes a small tree. The following stations are verified by the writer's specimens: Mt. Shasta, 1894; Shasta Springs, 1894; Emigrant Gap, 1898; Bubbs Creek, S. Fork Kings River, no. 798; Mineral King, no. 1161; Kern Cañon, no. 791; Ace-beam Ridge near Castle Peak, Mendocino County, 1897; Trinity Summit, no. 2034.

2. **Prunus demissa** Walp. WESTERN CHOKE-CHERRY. Erect slender deciduous shrub, 2 to 10 feet high, or rarely a small tree up to 35 feet in height; leaves oblong-ovate or more commonly oblong-obovate, acute at apex or abruptly short-pointed, finely serrate, 1 to 3½ inches long; petioles ½ inch long, with 1 or 2 glands just below its summit; racemes 2 to 4 inches long, terminating more or less leafy peduncles; drupe red or dark purple, 3½ lines long, astringent.

Sierra Nevada, 2000 to 5000 feet and Coast Ranges, 500 to 3000 feet. Ranging northward to British Columbia and eastward to the Rocky Mountains. The writer has collected it as follows: Palomar, no. 1495; Santa Lucias, 1901; Berkeley Hills, no. 2362; upper Napa Valley, 1897; Jackson Valley, Mendocino County, no. 1866; Middle Eel River, east of Round Valley, 1897; Sisson, 1894; Yosemite Valley, 1896.

3. **Prunus ilicifolia** Walp. ISLAY. Evergreen shrub or small tree, 8 to 25 feet high; old bark dark brown or almost black, closely checked; leaves coriaceous, elliptic or ovate, acute or obtuse, spinose-toothed, 1 to 2 inches long, short-petioled; racemes 1 to 2½ inches long, on axillary leafless peduncles;

flowers 2 lines long; drupe red or dark purple, 6 to 8 lines thick, slightly obcompressed, apiculate; flesh thin, sweetish when ripe.

Islay grows in the South Coast Ranges from San Francisco to the San Jacinto River and has also recently been found at one station in the North Coast Ranges, viz., Cordelia, *W.L. J.*, no. 3076. It is not uncommon in cultivation and is also called Evergreen Cherry and Holly-leaved Cherry.

Var. **integrifolia** Sarg. Tree 10 to 45 feet high or often of bushy form; leaves oblong-ovate, usually entire, 3 to 6 inches long.—Islands of the Southern California coast and Lower California.

On Catalina Island this Island Cherry is abundant in Swain and other cañons on the north coast, usually forming small colonies towards the bottoms of the cañons or in protected places. All the individuals observed on Catalina by the author were stump sprouts from old root crowns. Sometimes large irregular circles of trees evidently belong to one old root system. In one small clump there were five trunks ranging from ten to twelve inches in diameter at three feet above the ground; the trees were forty-five feet in height.

4. **Prunus subcordata** Benth. Sierra Plum. Deciduous shrub 5 to 7 feet high or sometimes arborescent and 20 feet high, with crooked and rough gray-brown branches and more or less spinescent branchlets; leaves ovate, elliptic to almost round, obtuse or truncate at base, rarely subcordate, 2 inches long or less, on petioles 2 or 3 lines long; flowers appearing with the leaves, 2 to 4 in a cluster, on pedicels ½ inch long; sepals linear or slightly acute, 1½ lines long; petals obovate, somewhat concave, 4 lines long; stamens 25 or 30; drupe red, ¾ to nearly 1 inch long, the pulp rather hard but more or less edible.

Sierra Nevada, northward to southern Oregon, thence southward through the Coast Ranges to Contra Costa County. Most abundant in the northern Sierra Nevada, Modoc, and Siskiyou regions, where it is used in rural cookery. It makes an excellent preserve or jelly and is sometimes canned or dried in quantity. At Fort Bidwell there is also a scrubbier form called Hog Plum, according to Mrs. H. M. Manning, which grows at lower altitudes and has smaller, rougher fruit, drier flesh and tougher skin. In the North Coast Ranges more commonly with sterile fruits, often half or full size but bladdery-inflated.

## 3. Pyrus L. Pear; Apple.

Trees or shrubs with simple deciduous leaves and stipules which disappear early. Flowers in corymbs. Calyx-tube urn-shaped. Petals white or pink, with claws. Styles 2 to 5, united at base; ovules 2 in each cell of the inferior ovary, the carpels more or less coriaceous. Fruit a pome, in the subgenus Malus (apple) more or less globose and sunken at each end.—Forty to fifty species.

### 1. **Pyrus rivularis** Dougl.

OREGON CRAB-APPLE.

PYRUS RIVULARIS Douglas in Hooker, Fl. Bor. Am., vol. 1, p. 203, t. 68 (1839); Nuttall, Sylva, vol. 1, p. 172 (1865); Sargent, Silva N. Am., vol. 4, p. 77, t. 170 (1892).

*Malus rivularis* M. J. Roemer, Syn. Monog., vol. 3, p. 215 (1847); Jepson, Fl. W. Mid. Cal., p. 287 (1901).

Tree 15 to 30 feet high, or often a many-stemmed shrub, leaves ovate, pointed, serrate, green above, pale, pubescent and eventually rusty beneath, 1 to 3¾ inches long, those of the sterile branchlets mostly 3-lobed or with a coarse tooth on each side, those of the flowering branchlets rarely lobed or toothed; corymbs 6 to 8-flowered; petals elliptical, 5 lines long, commonly with toothed auricles just above the very short claw; stamens about 20; carpels commonly 3, each 2-ovuled, usually but 2 ovules maturing, one carpel being wholly abortive; fruits 2 or 3 in a cluster, oblong or oblong-ovoid, 6 or 7 lines long and 4½ or 5 lines broad, not sunken at base, yellowish (or pinkish on one side), aging purple-black; calyx-lobes at length deciduous.

The Oregon Crab-apple inhabits the Coast Ranges from Sonoma to Eureka and northward through Oregon and Washington to Alaska. It flowers in April and May, and fruits in November. It is a rare tree in the southernmost part of its range.

## 4. LYONOTHAMNUS Gray.

Shrub or tree with thin bark exfoliating in long loose strips and opposite polymorphic petioled leaves. Flowers numerous in a much-branched terminal panicle. Petals 5 and stamens 13 to 16, inserted on the margin of the woolly disk lining the calyx-tube which bears 5 lobes. Pistils 2, distinct, each with a spreading style and capitate stigma. Fruit consisting of two woody 4-seeded carpels dehiscent ventrally and partly dehiscent dorsally.—One species.

### 1. **Lyonothamnus floribundus** Gray.

CATALINA IRONWOOD.

LYONOTHAMNUS FLORIBUNDUS Gray, Proc. Am. Acad., vol. 20, p. 292 (1885); Brandegee, Zoe, vol. 1, p. 111, pl. 5 (1890); Trask, Erythea, vol. 7, p. 141 (1899).

*L. asplenifolius* Greene, Bull. Cal. Acad., vol. 1, p. 187 (1885); vol. 2, p. 149, pl. 6 (1887).

A shrub with several stems 3 to 15 feet high or becoming a slender tree three times as high with trunk 4 to 10 inches in diameter; leaves Oleander-like, linear, tapering above to an acute apex, subentire, 3 to 5 inches long and ½ to ¾ inch wide, petioled; they vary (*a*) into oblong entire leaves 1½ inches wide, (*b*) into deeply pinnately cut leaves with serrulate margin, recalling an Asple-

nium fern, or (*c*) into irregularly pinnate leaves with 2 to 5 leaflets, the leaflets similar in size and shape to the blades of the simple leaves and as variable; flowers white, 3 lines broad, in terminal clusters 3 to 6 inches broad; calyx-tube hemispherical, woolly outside, with nearly triangular lobes; petals orbicular, sessile, white, crenulate-edged.

The Catalina Ironwood is an insular species found only on the islands of Santa Catalina, San Clemente, Santa Rosa, and Santa Cruz. It is common on Santa Catalina where it ranges altitudinally from 500 to 2000 feet and grows by itself, forming little groves one-half to one-quarter acre in area or less, on the steepest and rockiest north slopes. There are three fine groves in Swain Cañon. In the lower one the trees are pole-like, twenty to thirty-five feet high, mostly branching in the top only. The trunks are three to six inches in diameter, cylindric or sometimes showing a tendency to become flattened or board-like. Most of the original trees in this grove have been cut and the stand represents second growth from stump sprouts. The second grove, in the middle fork of the cañon, has somewhat larger trees. The largest tree here is fifty-five feet high and one foot one inch in diameter at two feet above the ground. A third or upper grove lies in a cañon to the left of the middle cañon; the trees are nearly as tall as in the second grove.

On the Santa Rosa, Santa Cruz, and San Clemente islands the trees exhibit fern-like divided leaves (= *L. asplenifolius* Greene), the entire-leaved form being absent from these islands, whereas on Santa Catalina the entire-leaved form is dominant. This note as to the distribution of the fern-leaf type is on the authority of Mrs. Blanche Trask, who has studied the vegetation of Catalina Island more thoroughly than any one else and who has likewise visited and studied the other coast islands.

The pinkish red wood is very heavy, hard and close-grained. On account of its great strength it is used for fish-poles and also for canes and similar articles. This species has long been in cultivation but attempts to propagate it have not been very successful. Seed, which is not easily procurable in quantity, germinates a very small percentage; and of the seedlings a very small percentage survive. No truly successful method of rooting cuttings has yet been made in our experiments (*W. G. Perrine*), although it is said basal sprouts set roots more readily. A tree in the Botanic Garden of the University of California is sixteen years old from seed, the seed having been gathered on Santa Cruz Island in 1894 by Dr. Franceschi.

The generic name Lyonothamnus is in honor of William S. Lyon of Los Angeles, who sent specimens which he had collected on Catalina Island to Asa Gray in 1884. This was apparently not the first discovery, as I am told by Mrs. K. Brandegee that at an earlier date specimens had been sent to Europe by Gustav Eisen.

## LEGUMINOSAE. Pea Family.

Herbs, shrubs, or trees. Leaves alternate, stipulate, compound or rarely simple. Flowers perfect, somewhat perigynous (frequently more on one side than the other), or hypogynous. Calyx synsepalous, usually 5-toothed or cleft, or sometimes bilabiate, mostly persistent. Corolla with 5 petals, regular or in ours commonly papilionaceous, *i.e.*, highly irregular and butterfly-like, with an upper petal or "banner," 2 lateral petals or "wings," and the 2 lower petals joined by their edges to form the "keel," usually with free claws. Stamens 10, united into a sheath around the ovary (monadelphous), or the upper stamen distinct from the others (diadelphous), or sometimes all distinct. Pistil 1, 1-celled, with single style and stigma. Fruit a 2-valved pod or legume, with 1 or 2 rows of seeds on the ventral side, commonly opening by both the dorsal and ventral sutures, or sometimes indehiscent. Seeds without endosperm.

Key to the Genera.

Stamens distinct; corolla regular or imperfectly papillionaceous; leaves bipinnate; branches more or less spiny.

Flowers small, regular; calyx campanulate; stamens much exserted ..... 1. Prosopis.

Flowers medium-sized, the upper petal larger; calyx with stipe-like tube; stamens included ..... 2. Cercidium.

Stamens monadelphous or diadelphous; corolla papillionaceous.

Leaves simple, glandular-dotted; branchlets numerous, spinose ..... 3. Dalea.

Leaves once pinnate, without glandular dots; spines in pairs below petioles ..... 4. Olneya.

### 1. Prosopis L.

Shrubs or trees, the branches armed with spines and without terminal buds. Leaves alternate on the season's shoot, fascicled in earlier axils, deciduous, bipinnate with 1 or 2 pairs of pinnae, the leaflets small, numerous, entire and in equal pairs. Flowers regular, small, greenish, sessile, in axillary pedunculate cylindrical spikes. Calyx campanulate, with short teeth, deciduous. Petals 5, connate below the middle or at length free, tomentose on inner side, very much exceeding the calyx. Stamens 10, free, exserted, the anthers tipped with a deciduous gland. Ovary stipitate, villous; style filiform. Pod straight, curved or coiled, indehiscent, the many seeds separated by thick spongy partitions.—About twenty species, tropical and subtropical regions of both hemispheres.

Key to the Species.

Leaflets 10 to 15 pairs; spines axillary, in pairs, singly or none; pod straight or curving, compressed ..... 1. *P. juliflora.*

Leaflets 5 to 8 pairs; spines in pairs, stipular; pod spirally coiled into a straight cylindric body ..... 2. *P. pubescens.*

## 1. **Prosopis juliflora** DC.

MESQUITE.

PROSOPIS JULIFLORA DeCandolle, Prodr., vol. 2, p. 447 (1825); Sargent, Silva N. Am., vol. 3, p. 101, t. 136, 137 (1892); Brewer and Watson in Bot. Cal., vol. i, p. 163 (1876); Coville, Bot. Death Val. Exped., p. 89 (1893).

MESQUITE, Palmer, Rep. U. S. Com. Agri., p. 410 (1870).

Shrub or small tree with short trunk dividing into crooked branches commonly forming a rounded or depressed crown, 10 to 15 or rarely 35 feet high in California; petioles abruptly enlarged and glandular at base, bearing usually 2 pinnae, with 10 to 15 pairs of linear leaflets ½ to 1 inch long; stipules linear and membranaceous; spines axillary often in pairs or sometimes absent, ¼ to 1¼ inches long; flowers 2 lines long, condensed in slender cylindrical spikes mostly 2 to 3½ inches long; stamens twice as long as the petals; pods borne in drooping clusters, 1 to 6 to each spike, linear, at first flat, later becoming thickened, falcate, 4 to 8 inches long, commonly 4 or 5 lines broad, irregularly constricted between the seeds which are about 3 lines long.

The Mesquite, or Algaroba of the Mexicans, is a characteristic xerophyte of the Colorado Desert of Southern California where it occurs singly or in small groves. It ranges westward to San Jacinto Lake and San Diego, northward through the Mohave Desert to Kern County and Death Valley, eastward to Texas, and southward in various forms to Chile. It attains its best development in the desert region where its roots go down forty to sixty feet for water. In California it is very diverse in habit; most often a shrub with several stems, it becomes a tree along rich, moist bottoms of the Colorado River, or out on the desert trailing over the ground in exposed situations. Shifting sand blown about by winds may bury a shrub so that only the terminal branches remain uncovered. Thus large mounds gradually arise which are often excavated for the wood and yield one-half to three cords from a single plant. It is one of the staple food plants of the native tribes of the Southwest and of Southern California. In years of a heavy crop the beans are borne so abundantly as to bend the branches almost to the ground. The Indians grind the whole pod, husk and seed, into an imperfect meal for bread. The process of preparation and subsequent consumption has been vividly described by Dr. C. E. Palmer, an army surgeon: "The pods in their fresh ripe state are put into a wooden or stone mortar and bruised, then emptied into an earthen dish, mixed with water and allowed to stand for a few hours, the result being a kind of cold porridge or mush. All present then collect around the newly prepared mess, seating themselves on the ground near the dish, and, pressing the fingers of the right hand tightly together, at the same time bending the hand so as to form a scoop,

dip in without ceremony, and without distinction of rank, age or sex, forming a grotesque sight rarely to be witnessed outside of an Indian camp. The nearly naked bodies of the Indians soon become smeared from head to foot, and the shaggy appearance of their hair does not exhibit a lively sense of cleanliness. Each face wears a complaisant look, while their tumid abdomens afford certain proof of the quantity consumed."

Cattle also eat the pods and Indian ponies learn the trick of getting them off the tree without being scratched by the spines. The wood is used by the Indians for rafters and posts in their houses and for stools and wooden mortars. It makes excellent fuel and is one of the great resources of settlers and miners in the desert region. Being a bee-food tree it is often called Honey Mesquite and produces an abundance of good but dark-colored honey.

### 2. **Prosopis pubescens** Benth.

Screw Bean.

Prosopis pubescens Bentham, Lond. Jour. Bot., vol. 5, p. 82 (1846); Coville, Bot. Death Val. Exped., p. 89 (1893); Brewer & Watson, Bot. Cal., vol. 1, p. 163 (1876); Sargent, Silva N. Am., vol. 3, p. 107, t. 138 (1892).

*Strombocarpus pubescens* Gray, Pl. Wright, pl. 1, p. 60 (1852); Torrey, Pac. R. Rep., vol. 5, p. 360, t. 4 (1857).

Shrub or small tree, 10 to 25 feet high with trunk 3 to 10 inches in diameter and branches armed with stout stipular spines 2 to 6 lines long; leaves canescently puberulent, the leaflets in 5 to 8 pairs, oblong, 1 to 5 lines long; flowers 2 lines long, borne in spikes 2 to 3 inches long, each spike setting 2 to 15 pods; pod coiled into a narrow straight cylindric body 1 to 1½ inches long; seeds less than 1 line long.

The Screw Bean, Screw-pod Mesquite, or Tornillo of the Mexicans, grows in sandy or gravelly washes or ravines and is distributed throughout the Colorado and Mohave deserts of Southern California, northward to Death Valley, eastward to southern Utah and New Mexico, and southward to northern Mexico. The beans are sweet and nutritious and are used as food by the Indians and fed as fodder to cattle.

## 2. Cercidium Tulasne.

Shrubs or small trees, often armed with short spines. Leaves bipinnate with one or two pairs of pinnae and 2 to 4 equal pairs of leaflets. Flowers on jointed pedicels in short axillary racemes. Calyx shortly campanulate, the limb cleft into 5 reflexed deciduous lobes. Petals bright yellow, clawed, the upper one broader than the rest, a little auricled at base of blade, and with longer

claw. Stamens 10, distinct, the filaments hairy at base, one or two next upper petal gibbous on one side toward base. Pod compressed, 2-valved, narrow, pointed at each end, more or less constricted between the flat seeds.—Five species, southwestern United States southward to Chile.

### 1. **Cercidium Torreyanum** Wats.

PALO VERDE.

CERCIDIUM TORREYANUM Sargent, Gard. & For., vol. 2, p. 388 (1889), Silva N. Am., vol. 3, p. 85, t. 130 (1892).

*Parkinsonia Torreyana* Watson, Proc. Am. Acad., vol. 11, p. 135 (1876); Brewer & Watson, Bot. Cal., vol. 1, p. 162 (1876).

*Cercidium floridum* Torrey, Pac. R. Rep., vol. 5, p. 360, t. 3 (1857), not of Bentham.

Small intricately branched tree, 15 to 20 feet high, with short trunk, smooth green bark, and leafless for most of the year; spines 2 or 3 lines long; leaflets oblong, 2 to 4 lines long; pedicels 5 to 8 lines long, jointed near the middle, the joint not obvious until the fruit has matured; flowers ¾ inch broad, in axillary racemes; petals orbicular to ovate, yellow, 4 to 5 lines long; pods 2 to 3 inches long, with a double groove along the ventral suture, often conspicuously constricted between the seeds.

The Palo Verde is common in sandy washes or depressions throughout the Colorado Desert of Southern California, eastward into southern Arizona and southward into Lower California and Sonora. The leaves fall soon after they appear in March but the trees still present a cheerful appearance on account of the bright green bark (whence the Spanish name), which is all the more pleasing on account of the contrast with the parched desert scenery. The pods fall in July and are harvested by the native tribes of the region who prepare them for food. The branchlets are browsed by cattle, horses, and deer and the flowers are visited by the honey-bee.

## 3. DALEA L.

Glandular punctate herbs, small shrubs or small trees. Leaves unequally pinnate or simple; stipules small, subulate; leaflets small, entire. Flowers in terminal spikes or racemes. Calyx with 5 nearly equal teeth or lobes, persistent. Banner cordate with free claw; claws of wings and keel adnate to the cleft staminate tube. Stamens 10, rarely 9, monadelphous. Pod ovate, compressed, usually indehiscent, more or less included in the calyx, 1 to 2-seeded. Seeds reniform.—One hundred species, mainly southwestern United States and southward to Chili.

### 1. **Dalea spinosa** Gray.

SMOKE TREE.

DALEA SPINOSA Gray, Pl. Thurb., p. 315 (1854); Torrey, Pac. R. Rep., vol. 7, pt. 3, p. 9, pl. 3 (1856); Brewer & Watson in Bot. Cal., vol. 1, p. 143 (1876); Sargent, Silva N. Am., vol. 3, p. 35, t. 111 (1892).

Very spinose and nearly leafless ash-gray low shrub or small tree, 4 to 25 feet high with intricately much branched top and trunk 2 to 10 inches in diameter; branchlets numerous and reduced to slender spines 1 to 1½ inches long, coated with a close white pubescence, sparingly sprinkled with small glands and minute caducous bracts, ultimately glabrous; leaves few, simple, cuneate- or linear-oblong, nearly sessile, ½ to 1 inch long, marked with a few large glands and persisting only a few weeks; flowers violet-purple, 4 to 5 lines long, borne in a spinescent spike, ½ to 1 inch long; calyx-tube turbinate, conspicuously 10-ribbed, with short obtuse teeth and marked by a row of conspicuous glands; petals attached only by their bases to the staminate tube; banner furnished at base of blade with 2 conspicuous glandular processes; ovary densely pilose on the margins, with several dot-like glands on the sides and containing 6 ovules; pod twice longer than the calyx, 1-seeded.

The Smoke Tree is common in dry washes from Palm Springs and the Chuckawalla Bench eastward throughout the Colorado Desert to the Gila River in Arizona, and southward to San Felipe, Sonora, and Lower California. It has been so named on account of its appearance, being so truly deceptive as to cause the uninitiated to watch it with speculative wonder as to where "that column of smoke comes from." The species was described from Thurber's specimens collected in 1852 on the Gila River and the Colorado Desert, although imperfect specimens had been gathered by Fremont in 1849.

### 4. OLNEYA Gray.

Small tree with thin scaly bark, slightly angled branchlets, pinnate leaves with entire leaflets, and often armed with stout spines in pairs below the leaves. Flowers few, in axillary racemes. Calyx subcampanulate, 5-lobed. Banner orbicular, deeply emarginate, reflexed; wings oblong; keel broad, obtuse, incurved. Stamens 10, diadelphous. Ovary with numerous ovules; style bearded above. Pod thick, broadly linear or ovate, with coriaceous valves, 1 to 2-seeded, tardily dehiscent.—One species.

### 1. **Olneya Tesota** Gray.

DESERT IRONWOOD.

OLNEYA TESOTA Gray, Pl. Thurb., p. 328 (1854); Torrey, Pac. R. Rep., vol. 7, p. 10, t. 5 (1856); Brewer & Watson in Bot. Cal., vol. 1, p. 157 (1876); Sargent, Silva, N. Am., vol. 3, p. 49, t. 116 (1892); Parish, Zoe, vol. 4, p. 341 (1894).

A spreading tree 15 to 20 feet high with short trunk ¼ to 1 or rarely 1½ feet in diameter; leaflets 5 to 7 pairs, cuneate-oblong or -obovate, obtuse or notched at apex, 3 to 6 lines long; stipular spines stout, straight or slightly curved, 1 to 4 lines long; flowers violet-purple, 4 or 5 lines long, 3 to 10 in loose racemes ½ to 1¼ inches long; pods glandular, more or less pubescent and often provided with tack-shaped glands, ½ to 3 inches long, 1 to 8-seeded, more or less constricted between the seeds; seeds ovoid-globose, 4 to 6 lines long.

The Desert Ironwood, or Arbol de Hierro of the Spanish Californians, grows in the desert valleys of Southern California from San Felipe northward to Chuckawalla and Indio, eastward to Arizona, and southward into adjacent parts of Mexico. Its wood is remarkably hard and heavy and is used by desert Indians for arrow parts and tool-handles.

## SAPINDACEAE. BUCKEYE FAMILY.

Trees or shrubs with opposite compound petioled leaves, no stipules, and irregular flowers. Ovary superior, 3-celled with 2 ovules in each cell, commonly but one ovule maturing. Endosperm none.

### 1. AESCULUS L. HORSECHESTNUT.

Leaves palmately compound with serrate leaflets. Flowers showy, ill-scented, on jointed pedicels in a terminal cylindrical thyrse; they are of 2 sorts, perfect (fertile) with long thick styles and sterile with short styles; fertile flowers few near top of thyrse. Calyx tubular, unequally cleft. Petals 4 or 5, slightly unequal, clawed. Stamens 5 to 7, becoming successively much exserted and often unequal. Fruit a large 3-valved capsule, loculicidally dehiscent. Seed-coat thick and polished, with a large round scar; cotyledons very large and fleshy.—Thirteen species, northern hemisphere, eight in America.

## 1. **Aesculus californica** Nutt.

### California Buckeye.

Plate 79.

Aesculus californica Nuttall, in Torrey & Gray, Fl. N. Am., vol. 1, p. 251 (1838), Sylva, vol. 2, p. 16, pl. 64 (1865); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 20, 69, fig. 1 (1857); Hooker, Bot. Mag., vol. 84, t. 5077 (1858); Brewer & Watson, Bot. Cal., vol. 1, p. 106 (1876); Chesnut, Contrib. U. S. Nat'l Herb., vol. 7, p. 366 (1902); Coville, Bot. Death Valley Exped., p. 80 (1893); Parish, Zoe, vol. 4, p. 340 (1894); Jepson, Fl. W. Mid. Cal., p. 251 (1901).

*Calothyrsus californica* Spach, Ann. Sci. Nat., ser. 2, vol. 2, p. 62 (1834).

Tree commonly 10 to 18 or occasionally 30 feet high with the low rounded crown of greater breadth than the height, or frequently a shrub 5 to 10 feet high and often with several erect stems from the base; trunk 3 inches to 3 feet in diameter, invested by a smooth white bark which on old trunks becomes fissured into thinnish scaly plates 1 or 2 inches long and one-half as broad; leaves palmately compound with 5 to 7 leaflets; leaflets oblong-lanceolate to oblong-elliptic, acute or acuminate, serrulate, 3 to 5 inches long, petiolulate; flowers 4 to 8 lines long, white or sometimes pinkish, borne in a cylindrical cluster 4 to 6 inches long, the 1 to 9 fertile ones in the upper part of the cluster; limb of petals elliptic or ovate, rotately spreading; after fertilization the sterile flowers fall away and the fertile flowers of the thryse set 1, or sometimes 2 to 9, pods which are pendulous on the now naked axis of the inflorescence; pods 1½ to 2½ inches in diameter, eventually releasing by three valves one large polished brown seed about 1¼ to 2¼ inches in diameter and with very tough coat.

The California Buckeye is common throughout the Coast Ranges and foothills of the Sierra Nevada. In the Coast Ranges it is distributed from the south fork of the Salmon River (the most northerly locality) and Martin's Ranch at South Fork Trinity southward to San Luis Obispo, Fort Tejon, and Antelope Valley (the most southerly locality), and from the inner ranges (Salt Creek fork of the Cottonwood, Vaca Mountains, Mt. Diablo, Warthan Creek) westward to those near the coast (Petrolia, Pt. Reyes, Santa Cruz Mountains, Santa Lucias). It is most characteristic of the northerly or easterly bases and lower slopes of the foothills, or the banks of cañon water-courses or gulches, but is also found in moist flats only a few feet above the sea-level, as at Inverness and Berkeley. In general it is not common above 2000 or 2500 feet but ranges higher in particular localities southward. It occurs at 3700 feet on Cedar Creek, north fork of the Kaweah; at 4500 feet, two miles above Cluffs Cave, on the south fork of the Kaweah; and at 5000 feet southwest of the Comstock mill on Limekiln Creek, Sierra National Forest. The trees are usually scattered in thinly wooded brush-covered country but in many places on the foot-

hills they grow by themselves in open groves or form thickets eight to twelve feet high. Its general geographical area corresponds remarkably with that of the Digger Pine, save that the Buckeye extends somewhat lower in the hills and somewhat higher in the mountains and ranges nearer the coast. It is not found east of the Sierra Nevada mountains, nor does it occur in the inner mountain valleys of that range but only in the western valleys or western slopes. It was first collected by Dr. P. E. Botta near Monterey in 1829. Nuttall gathered it in the same locality in 1835.

The largest trees known to me grow on the alder flats of the Point Reyes Peninsula near Inverness, ten to twenty feet above sea-level. Here are many trees with broad crowns, twenty to thirty feet high, and with trunks four to five feet in diameter breast-high but much swollen at the ground, where they are six to eight feet in diameter. Some of these trunks are very aged and hollow and have renewed their crowns with as many as twenty to twenty-four new limbs. On the Mattole River near Petrolia are many fine trees, one thirty feet high, the perfect trunk two feet nine inches in diameter at two feet six inches from the ground (the smallest place) and branching at five feet and six inches from the ground. There is also an interesting grove near the coast west of Petrolia.

The wood is creamy white, soft, satiny, and compact. It is somewhat used for fuel and is prized by mountaineers for brake shoes. For the latter purpose a curved piece is preferable; no other wood holds the wheel so well and lasts so long. Buckeye trunks or limbs when large enough are good for wire-fence posts; in the Kaweah country I was told that they are remarkable for durability, outlasting Big Tree wood for the like purpose.

The tree has no reputation with Californians for ornamental purposes and yet it should be valued for gardens, estates, and parks. In this land where conifers and broad-leaved evergreens predominate it is almost unique among native trees for the fresh beauty of its spring foliage which completely hides the branching stems, the pleasing symmetry of its low broad crowns, and its display of showy flowers.

When eaten in sufficient quantity in "starvation years" the seeds will kill cattle because of their powerful astringency. They were, however, one of the food resources of the native tribes who made them wholesome by leeching and boiling. The color, size, and hanging position of the pods explain the name "California Pear" given the tree by the gold-seeking pioneers.

Buckeye regenerates freely by stump sprouts, which have dark-brown and not white or even pale bark. Pods are produced in enormous quantity but on account of the size of the seeds few of them are covered sufficiently to establish seedlings, although they germinate freely lying on the surface of the ground.

## ACERACEAE. Maple Family.

Trees or shrubs with opposite leaves. Flowers regular, polygamous or dioecious, borne in axillary or terminal racemes, corymbs or fascicles. Calyx generally cleft into 5 segments, the petals as many or none. Stamens 3 to 10, borne on the edge of a disk or hypogynous. Pistil 1 with a 2-lobed 2-celled ovary and 2 styles. Ovary developing a long wing from the summit of each lobe and thus ripening into a double samara; samaras separable at maturity, the wings serving to rotate them rapidly in the air and further their horizontal flight when carried away by the wind.

### 1. Acer L. Maple.

Leaves simple and palmately lobed, or pinnately compound, always petioled. Flowers small, in various kinds of clusters but the clusters always drooping.—Sixty to seventy species in the northern hemisphere, nine in North America.

Key to the Species.

Leaves simple; petals present.
- Flowers in racemes; samaras more or less hispid; leaves large deeply 5-lobed ..... 1. *A. macrophyllum.*
- Flowers in corymbs; samaras glabrous.
  - Leaves shallowly but acutely 7 to 9-lobed ..... 2. *A. circinatum.*
  - Leaves mostly 3-lobed or parted ..... 3. *A. glabrum.*

Leaves pinnately or ternately compound; flowers dioecious; petals none ..... 4. *A. Negundo.*

#### 1. **Acer macrophyllum** Pursh.

Big-leaf Maple.

Plate 80, figs. 1, 2.

Acer macrophyllum Pursh, Fl. Am. Sept., vol. 1, p. 267 (1814); Hooker, Fl. Bor. Am., vol. 1, p. 112, t. 38 (1838); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 21, 69 (1857); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 28, 57 (1860); Nuttall, Sylva, vol. 2, p. 24, pl. 67 (1865); Brewer & Watson, Bot. Cal., vol. 1, p. 107 (1876); Parish, Zoe, vol. 4, p. 341 (1894); Jepson, Fl. W. Mid. Cal., p. 252 (1901).

Handsome tree 20 to 65 feet high; trunk 1 to 3 feet in diameter with brownish gray bark divided into narrow ribbon-like ridges which interweave or interlock, or sometimes transversely fissured into small squarish plates; leaves roundish in outline, most commonly 3 to 9 inches, but even as much as 15 inches broad, palmately parted into 5 broad fingers which are mostly 2 or 3-lobed or

toothed; petioles 2 to 10 inches long; flowers yellowish white, borne in drooping racemes 2 to 4 inches long, perfect and staminate mixed in the same raceme, the lower half of the raceme sometimes wholly staminate; sepals elliptic, 2½ lines long, equalled by the oblong petals; stamens 7 to 9, those of the staminate flower exserted; body of the fruit densely covered with short stiff hairs and eventually separable into two parts; wings 1¼ to 2 inches long, 6 to 8 lines wide.

The Big-leaf Maple inhabits the banks of rivers and perennial creeks in the valleys, and mostly the north and east slopes of mountains, choosing moist swales or the neighborhood of springs. It is found in the Sierra Nevada and Coast Ranges, southward to Southern California and northward to southeastern Alaska. In the Sierra Nevada it occurs between 2000 and 5000 feet altitude in mountain valleys or along cañon streams (Bear Valley, Nevada County; Yosemite Valley; Cedar Creek, North Fork Kaweah). In Southern California it occurs in the cañons on the southerly slope of the San Bernardino and Sierra Madre ranges at about 3000 feet altitude and in the cismontane region of Southern California as far as Hot Springs Valley, San Diego County, which is the southernmost reported locality. It grows in the Santa Inez Mountains, ranges north to the Santa Lucia and Santa Cruz mountains, Alameda Creek, Oakland Hills, and Mt. Diablo. In all the above regions it is nowhere a common tree.

It is an occasional tree along streams in the North Coast Range valleys, occurs in Marin and Sonoma counties, is common on the eastern slopes of Twin Sisters Peak in the southern extremity of the Napa Range and on the low hills rising from the west side of the Napa Valley floor, where its yellowing foliage dapples the open woods in autumn. It becomes more frequent as one travels northward through the counties of Mendocino and Humboldt. On the river benches of the upper Mattole are many fine trees, while near Camp Grant on the main Eel River individuals ninety-five feet high are found. It is not known in the Sacramento or San Joaquin valleys on the main valley floor and is a rare tree in the inner North Coast Range, fronting the plains of the Sacramento Valley from the Vaca Mountains to the headwaters of Cottonwood Creek in Tehama County and northward to the Sacramento River cañon.

While not adapted to a wide range of physical conditions and always dependent upon a supply of surface or underground water, yet it is inured to considerable atmospheric extremes, since it may sometimes be found on Coast Range valley floors where the streams are dry in summer and the arid conditions extremely prolonged. Trees in such situations, as in the upper end of Bachelor Valley, Lake County, and near Mt. Diablo, or at 4000 feet on the Blue Rock Ridge have leaves 3 to 4 inches broad on petioles 1 to 2¼ inches long. The other extreme is a shade-enduring type, represented by small saplings in the Redwood Belt with leaves twice as large and petioles often 6 to 12 inches in length. As

a part of the low growth under the tallest and densest stand of *Sequoia sempervirens* along the main Eel River, these saplings with their slender stems and large graceful leaves nicely balanced on the long petioles against the faint light filtered through the high forest canopy, are in pointed contrast to the titanic features of the Redwood.

Notable individual trees are not common in California, the trunks of the largest specimens usually being damaged or hollowed by fire. In uncrowded situations the trunk branches at five or ten feet from the ground and develops a large, spreading round-headed crown, the most typical habit in our Coast Ranges. Again we may find several second-growth trunks replacing the original tree. A remarkably large tree, possibly the largest and most perfect in California, grows on the Van Arsdale Ranch in southern Mendocino County. It has not been seen by the author.

In southern Oregon, west of the Cascade summits, the Big-leaf Maple is most abundant and attains its greatest development, records having been made of trees as much as five feet in diameter and one hundred feet in height. It is here called "Oregon Maple" and is a valuable timber tree. Northward it enters Washington, where it is sometimes called "White Maple," and passes along the coast to British Columbia and southeastern Alaska, which is the northern limit of its range.

The wood is reddish brown with white sapwood. It is rather hard, with straight, close grain, takes a fine polish, works easily and furnishes the most valuable wood of any deciduous tree of the Pacific Coast, being used for furniture, interior finish and tool handles. The second-growth saplings are chosen for single-trees by the mountaineers. The Indians of Oregon and Washington used the wood for boat paddles, gambling disks and sticks; with the Redwood Creek Indians of Humboldt County the twigs were used as "medicine" to bring riches, a fine compliment to those admirable qualities of the tree which are likewise appreciated by the white man. Sugar has been made from its sap by the mountaineers and the honey-bee works on its flowers.

This species was first collected by the Lewis and Clark Expedition across the continent in 1805-6, at the great rapids of the Columbia River. Nuttall, who saw it in the Willamette Valley in 1834, admired it greatly and published his praises in the "Sylva." The leaves and racemes of flowers appear from large winter buds which burst in March or April, the outer scales of the bud being ovate or roundish, the inner ones becoming very long and narrow—one to two and one-half inches in length—and often with rudiments of leaf-blades on their tips. The leaves are roundish in outline, three to twelve inches broad, sometimes indeed fifteen inches broad, and larger than those of any other maple. As an ornamental tree the Big-leaf Maple has been widely planted. It is also highly

valued as a street tree, being the most available native tree for this purpose, on account of its extremely rapid growth and its adaptability to street conditions.

2. **Acer circinatum** Pursh. VINE MAPLE. (Plate 80, figs. 5, 6.) Shrub or sometimes a small tree, erect and 5 to 20 feet high, but more often vine-like or reclining; trunk 3 to 6 inches or rarely 1 foot in diameter with a smooth thin brownish red bark; leaves 2 to 4 inches broad, 5 to 7-lobed to the middle, with toothed margin, the lower pair of lobes smaller; flowers 4 to 10 or more in a corymb, most of them staminate, the cluster often setting but one fruit; sepals reddish brown, oblong, acute, nearly twice as long as the petals and bearing a loose tuft of hairs on the back towards the apex; petals white or greenish, cordate, folded together at apex, 1 line long; stamens 6 to 10, shorter than the petals in the perfect flower but longer than the petals in the staminate flower; samaras destitute of hairs with the wings spreading at right angles to the stalk; wings 7 to 10 lines long, 4 to 5 lines broad, scarlet when full grown; as the fruit ripens the peduncle turns upward and finally the samara stands erect above the leaf.

The Vine Maple inhabits the banks of streams and the depths of forests from the cañon of the upper Sacramento River to Mendocino and Humboldt counties and northward to southeastern Alaska. It is an attractive feature of the bottom lands and great forests of Oregon and Washington, where it sometimes attains a height of thirty-five feet. Most commonly the trunk branches at the very base into four or five spreading stems which curve over and, touching the ground, take root. Further offsets arise and result in extensive and well-nigh impenetrable thickets.

Shady or half-shady low-lying localities with rich, moist soil best describe the habitat most pleasing to the Vine Maple and indicate the belt to which it is usually restricted. Like other species it may step out of its normal habitat and thus small colonies or stray individuals will sometimes be found in the most unpromising stations, the physical characteristics of which are out of harmony with those of the usual places of growth. Between Trinity Summit and Salmon Summit, in the high, broken country of northwestern California, is a long connecting ridge about 4000 feet above sea-level, called by the backwoodsmen the Devil's Backbone. Its knife-edge is interrupted by rocky vertebrae, over which a thin trails creeps up and down. Chaparral clothes the sides of it with an even growth and these shrubs, with stunted Knob-cone Pine, rocky soil and lack of springs, proclaim the dryness and exposure of the ridge. It seems no natural place for Vine Maple, yet Vine Maple grows all along the "Backbone," here and there, and thus manifests in such a situation an unusual degree of drought tolerance.

The wood is heavy, hard and close-grained, and takes a high polish; in Oregon and Washington it is used for fuel, tool-handles, cabinet-work, boat-knees and

barrel-hoops and for bowls and fish-net hoops by the native tribes of the Columbia River.

*Acer circinatum* was first collected by Lewis and Clarke in 1806 at the great rapids of the Columbia River. On account of its forming barriers in the forests it invariably attracted the attention of the early explorers. Save for the Mountain Dogwood, this species is well-nigh the only tree of the Pacific Coast whose leaves turn deep red in the autumn. Its handsome foliage assumes blood-red or scarlet colors and is one of the delights of travelers journeying through the Cow Creek Cañon of Oregon, where it occurs in great abundance, as well as in many other places west of the Cascade summits.

3. **Acer glabrum** Torr. Sierra Maple. (Plate 80, figs. 3, 4.) Shrub 5 to 10 feet high with slender branchlets, the stem 2 or 3 inches in diameter; leaves 1 to 3 inches broad, palmately 3-lobed or often with 2 supplementary lobes at base, the margin unequally serrate; flowers 4 to 9, in loose, umbel-like corymbs, the staminate without rudiments of pistils and the pistillate with short stamens; corymbs unisexual or with both pistillate and staminate flowers, the sexes often borne on different shrubs; petals of the same length as the oblong sepals but narrower; stamens 7 to 10, the glabrous filaments arising from pits in the perigynous cushion; fruits usually several in a cluster, glabrous, with diverging wings 6 to 12 lines long and 4 or 5 lines broad.

The Sierra Maple, also called Dwarf Maple, grows on the rocky sides of cañons at 6000 to 8000 feet in the Sierra Nevada Mountains, southward to the San Bernardino and San Jacinto mountains, northward to British Columbia and eastward to the Rocky Mountains. In the latter region many or all of the leaves on an individual may be replaced by three leaflets. In the Sierra Nevada, where the localities and individuals are comparatively few, it varies in breadth of wing, depth of leaf lobation and habit according to situation or exposure, some of the forms having been described as species, namely: *Acer miniusculum* Greene, Kern Cañon tributary; *Acer diffusum* Greene, Whitney Creek; *Acer Torreyi* Greene, above Donner Lake toward Donner Pass.

In California the Sierra Maple is probably most abundant in the Siskiyou Mountains, where small thickets are found on wet mountain sides at 5000 to 6000 feet. It also occurs on Marble Mountain and on the high peaks of northern Trinity County. In this region, northwestern California, the stems are usually in clusters, ten to one hundred and fifty in one bush-like clump; in the southern Sierras the shrubs generally have a single stem.

### 4. **Acer Negundo** L. var. **californicum** Sarg.

Box Elder.

Plate 80, figs. 7, 8; plate 81.

Acer Negundo Linnaeus var. californicum Sargent, Gard. & For., vol. 4, p. 148, Silva N. Am., vol. 2, p. 112, t. 97 (1891); Jepson, Fl. W. Mid. Cal., p. 252 (1901). Var. *Parishianum* O. Kuntze, Rev. Gen. Pl., vol. 1, p. 146 (1891).

*Acer californicum* Dietrich, Syn., vol. 2, p. 1283 (1840); Pax, Pflanzenreich, bd. 4, lief. 163, p. 44 (1902).

*Negundo californicum* Torrey & Gray, Fl. N. Am., vol. 1, pp. 250, 684 (1838); Hooker and Arnott, Bot. Beech., p. 327, t. 77 (1840); Nuttall, Sylva, vol. 2, p. 37, t. 72 (1865); Brewer & Watson, Bot. Cal., vol. 1, p. 108 (1876).

Tree 20 to 50 feet high with dark bark; leaves pinnately 3-foliolate, the leaflets commonly 1¼ to 6 inches long, serrate and incised, or deeply 2 or 3-lobed, or the lobes sometimes becoming distinct and petioled so that one or more of the primary leaflets are replaced by 2 or 3; flowers dioecious, without corolla and with minute calyx; staminate flowers clustered on thread-like hairy pedicels, the stamens 4 or 5; pistillate flowers borne in slender racemes; fruits finely pubescent, the wings 6 to 8 lines long, 4 lines broad, crimson when young.

The Box Elder grows along streams in the Coast Ranges and on the alluvial banks of the Sacramento and San Joaquin rivers in the Great Valley of California, thence southward to Santa Barbara and the San Bernardino Mountains. While widely distributed, the trees of a locality are few and scattered and it is nowhere abundant. I have collected specimens from the following middle California localities: Harding's Landing, Feather River; Grand Island, Lower Sacramento; Tomales Bay; Guerneville; Ukiah; West Branch, San Pablo Creek; Alvarado; Niles. It has been observed about Kingsley, Mariposa County, 2800 to 3300 feet. Douglas first collected it, although his exact locality is not known.

## CACTACEAE. Cactus Family.

Trees or shrubs with fleshy or woody stems more or less studded with clusters of thorns (modified leaves) and without normal foliage. Flowers complete. Sepals and petals many, passing one into the other. Stamens numerous, usually inserted on the base of the corolla. Pistil compound; ovary inferior, 1-celled, with many parietal placentae; style one with many branches. Fruit a berry; seeds without endosperm.

### 1. Cereus Haw.

Habit diverse. Cushions geminate, borne on the vertical ribs, the lower spine-bearing, the upper producing a branch or flower. Calyx elongated. Stamens adnate at base to calyx tube. Seeds black.

### 1. **Cereus giganteus** Engelm.

SUWARRO.

CEREUS GIGANTEUS Engelmann, in Emory's Rep., 159 (1848), Bot. Mex. Bound., p. 42, tt. 61, 62 (1859); Rothrock, Bot. Wheeler, frontisp. (1878); Brewer and Watson in Bot. Cal., vol. 1, p. 247 (1876); Sargent, Silva N. Am., vol. 5, p. 54, t. 210 (1893).

*Carnegeia gigantea* Britton & Rose, Jour. N. Y. Bot. Gard., vol. 9, p. 188 (1908).

PITAHAYA, Emory, Rep., pp. 74, 75, with figures opposite pages 72, 75, and 79 (1848).

Columnar tree, strongly 8- to 12-ribbed toward the base and with more numerous ribs above, ½ to 2 feet in diameter, 15 to 60 feet high, simple or with one or more (commonly 2 or 3) upright branches above the middle; flowers 4 to 4½ inches long; fruit oval, irregularly valvular-dehiscent.

The Suwarro, Giant Cactus or Monument Cactus, one of the most remarkable trees of America, grows in southern Arizona and crosses the Mexican line into the State of Sonora. It has only recently been discovered on the California side of the Colorado River between the Needles and Yuma where there are hundreds of trees. Its singular columnar growth and candelabra-like branches make it an extraordinary feature in the desert landscape of the regions it inhabits.

## CORNACEAE. DOGWOOD FAMILY.

Ours deciduous trees or shrubs. Leaves opposite, simple, entire. Flowers in cymes or heads. Calyx-tube coherent with the ovary, its limb represented by 4 small teeth at the summit or none. Petals 4, epigynous, valvate in bud. Stamens 4, alternate with the petals. Ovary 2-celled with a single pendulous ovule in each cell; style filiform, undivided.

### 1. CORNUS L. CORNEL. DOGWOOD.

Flowers regular and perfect, greenish or white, disposed in cymes or heads. Fruit a drupe, the stone 2-celled with 1 seed in each cell.—There are five and perhaps six other species in California, all shrubs of various sizes.

### 1. **Cornus Nuttallii** Aud.

MOUNTAIN DOGWOOD.

CORNUS NUTTALLII Audubon, Birds, t. 367 (1837); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 29, 63 (1860); Lyall, Jour. Linn. Soc., vol. 7, p. 134 (1864); Nuttall, Sylva, vol. 2, p. 117, t. 97 (1865); Sargent, Silva N. Am., vol. 5, p. 69, t. 214 (1893); Jepson, Fl. W. Mid. Cal., p. 361 (1901).

Slender tree, or often a shrub, 8 to 50 feet high, with smooth whitish bark; leaves roundish to narrowly obovate, with rounded or shortly acute apex, 3 to 5 inches long, on petioles 2 to 3 lines long; flowers crowded in dense heads on peduncles 1 to 1¼ inches long and surrounded by an involucre of white bracts; bracts commonly 6, roundish to obovate or oblong with a short abrupt point at apex, 1½ to 3 inches long; flowers dull white, 3 lines long; calyx 4-lobed; petals 4, broadly oblanceolate with 4 alternate exserted stamens; style single, surrounded at base by a yellowish glandular disk; fruit a scarlet drupe 5 or 6 lines long.

The Mountain Dogwood is an inhabitant of the depths of woods where the shade is deep and the soil moist. It is distributed from Mt. San Jacinto in Southern California northward through the Coast Ranges and Sierra Nevada to southwestern British Columbia. In the Sierra Nevada it is common between 2500 and 5000 feet elevation; in the Coast Ranges it is limited chiefly to the seaward ranges, and to the middle (Mt. St. Helena) range north of San Francisco Bay. In the San Bernardino Mountains and on Mt. San Jacinto it is found between 4000 and 5100 feet. Southward the tree is very infrequent and in the northern Coast Ranges of California it is always scattered and is commonly found in the depths of woods where it adorns chosen spots in late April or May with its handsome flower clusters, or again in autumn, when its foliage is dyed with scarlet hues.

On account of the small size of the tree it is of slight economic importance, although the wood is heavy, hard, tough and close-grained, and is used for mallets and tool-handles.

## ERICACEAE. Heath Family.

Trees, shrubs or perennial herbs, commonly with alternate leaves. Flowers regular, the parts usually in 5s. Stamens free or almost free from the corolla, as many or twice as many as its lobes; anthers 2-celled, opening by a terminal pore. Ovary superior or inferior, commonly 4 to 10-celled, with axile placentae and numerous ovules.

### 1. Arbutus L. Arbute Tree.

Evergreen trees or shrubs with glossy leathery leaves. Flowers in a terminal panicle of dense racemes. Calyx small, 5-parted, free from the ovary. Corolla globular or ovate, 5-lobed at apex. Stamens twice as many as the corolla-lobes, included; filaments soft hairy; anthers with a pair of reflexed awns on the back, each cell opening at the apex anteriorly by a pore. Ovary on a hypogynous disk, 5 or rarely 4-celled, the ovules crowded on a fleshy placenta which projects from the inner angle of each cell. Fruit a many-seeded berry with granular surface. —About 15 species; *A. Xalepensis* H. B. K. occurs in Mexico and Texas, and *A. arizonica* Sarg. in Arizona and Mexico.

## 1. **Arbutus Menziesii** Hook.

MADRONA.

Plates 82, 83; plate 2.

ARBUTUS MENZIESII Pursh, Fl. Am. Sept., vol. 1, p. 282 (1814); Newberry, Pac. R. Rep., vol. 6, pt. 3, pp. 23, 79, fig. 2 (1857); Nuttall, Sylva, vol. 2, p. 109, pl. 95 (1865); Gray, Bot. Cal., vol. 1, p. 452 (1876); Kellogg, For. Trees Cal., p. 78 (1882); Sargent, Gard. & For., vol. 3, pp. 509, 515, ill. (1890), vol. 5, pp. 146, 151, ill. (1895); Silva N. Am., vol. 5, p. 123, t. 231 (1893); Jepson, Fl. W. Mid. Cal., p. 372 (1901).

*Arbutus procera* Douglas, in Lindley, Bot. Reg., pl. 1753 (1836); Loudon, Arb. Britt., vol. 2, 1121 (1838).

Handsome tree 20 to 125 feet high, with a trunk ½ to 5 feet in diameter parting into spreading limbs adorned with glossy foliage; bark terra-cotta color and smooth, on old trunks dark brown and fissured into small loose scales; leaves narrowly elliptic or ovatish, 3 to 6 inches long, 1½ to 3 inches wide, rounded at apex or bluntly pointed, glabrous, dark green and polished above, glaucous beneath, the margin entire, or, on stump sprouts or vigorous shoots, finely serrate; petioles ½ to 1 inch long; flowers white, numerous in an ample, terminal cluster; calyx small, 5-parted; corolla ovate-globular, 3½ lines long, with 5 very small lobes recurving from the small opening, and 10 semi-transparent glands in a circle at base with a slight constriction above them which becomes obvious on drying; berry somewhat depressed globose, 4 to 5 lines in diameter, fleshy but rather dry, red, or orange color when not fully ripe; seeds somewhat angular, closely crowded, 5 or 6 in a cell.

The Madroña inhabits foothills or mountains, sometimes gravelly valleys, and is distributed from Southern California through the Coast Ranges northward to Vancouver Island. In Siskiyou County it extends east to Mt. Shasta and thence through the Sierra Nevada as far southward as Placer County at an altitude of 2500 to 4000 feet. Its geographical range has not been well known until recent years and even today essential details are wanting to the best understanding of its distribution, particularly concerning its occurrence in the Sierra Nevada, where it is an uncommon tree.

Its distribution in the Coast Ranges south of San Francisco Bay is worthy of detail. In cañons of the Berkeley and Oakland hills a few trees grow on little shoulders on north slopes. No localities are known for the Mt. Diablo region save only that Brewer records in his field book a tree on the easterly side of the mountain. It occurs sparingly in the Mt. Hamilton Range, but not in its long southward continuation, the Mt. San Carlos Range. It is a common tree in the Santa Cruz Mountains, is scattered throughout the Santa Lucia Mountains and occurs in the Santa Inez Range, but is very rare far southward. It has been reported from the San Bernardino, San Gabriel and Santa Monica

mountains. A few bushy individuals grow on Mt. Wilson in Los Angeles County and two trees occur on Palomar towards the village of Nellie. The Palomar trees are in a deep, remote cañon and on account of their rarity and isolation were objects of great interest to the native tribes, whose legends concerning them have come down to the white man. One of them is fifty feet high.

North of San Francisco the Madroña is widely distributed in the Coast Ranges except in the inner range, where it is absent or rare, as in the Vaca Mountains, where only a few isolated trees occur. While common on Mt. Tamalpais, in the mountains of Sonoma County, and in the Mt. St. Helena Range, it is most abundant in the high middle ranges of Mendocino and Humboldt counties, where as an associate of the Black Oak, Tan Oak, and Douglas Fir, it attains its greatest size. From the Ace-Beam Ridge, northeast of Round Valley, westward to the neighborhood of King's Mountain, which overlooks the Pacific Ocean, along all these mountain ridges, the Madroña is a continual delight to the traveler. Numerous fine trees abound and commonly attain a height of sixty to one hundred and twenty-five feet.

In this region too is found the largest and most remarkable individual of the species. From the lower Mattole country in southwestern Humboldt a wagon trail climbs to the Wilder Ridge, heavily wooded with Tan Oak, Douglas Fir and Madroña, and at the end of the ridge drops again to the ford of the Mattole River. On this downward slope a mile above the French and Pixton ranch-house the road passes around a little sharply-defined shoulder, on which, sixty feet from the wagon path, stands the "Council Madroña." It is an isolated individual with clean spaces around it and as seen from some little distance up grade the tree suggests an oak, merely on account of its exceptional size. The tree is 75 feet in height and its crown 99 feet wide in the longest direction. The trunk itself requires special description. Large Madroña trunks are usually badly hollowed or fire-burned, although appearing sound from one side; but the trunk of this tree is round and perfect, and without fire or axe-scars or traces of disease. At its narrowest part (16 inches from the ground), it has a girth of 24 feet 1½ inches, and at the ground exceeds this measurement only by a few inches. On the south side is given off a horizontally spreading limb 4 feet in diameter. Above the limb (at 4½ feet from the ground) the circumference of the trunk is 22 feet and 1 inch. At 10 feet the trunk parts into its main branches, giving rise to a broad but very rounded and symmetrical crown. Under its spreading limbs the coast tribes met the interior tribes in former days for the discussion of inter-tribal matters and for the conclusion of treaties. Situated on a little knoll on the mountain side it commands a view of the adjacent country and has been saved from destruction or injury by fires

through its local isolation in the surrounding forest. It was measured by the author in August, 1902.

While commonly but twenty to forty feet in height in the Bay Region, some exceptional individuals are very large and locally famous for their great spread of crown and diameter of trunk. The "Big Madroña of Lagunitas" stands on the south shore of the east arm of Lake Lagunitas in Marin County. The trunk, at the smallest part (three feet above the ground), is 7 feet 4 inches in diameter; it parts into six main arms grouped in two sets of three each, and supports a crown 100 feet in longest diameter and 72 feet in height. The trunk is heavily swollen at base, the longest diameter at the ground, from tip to tip of buttresses, being 20 feet. On the low ridge, right hand side of the wagon trail from the keeper's cottage to the Bon Tempe Ranch, there are three large Madroñas, one of which has a trunk diameter of 8 feet 4 inches at 3 feet 6 inches from the ground and a crown diameter of ninety feet. The main trunk is perfect outside but hollow inside. The second tree has a trunk diameter of 7 feet 5 inches at two feet, where it divides into three huge trunks. The trunk of the third has a diameter of eight feet at four feet above ground, with a great fire-burned hollow on one side. All of these trees are unequally and heavily buttressed at the ground. The "Sonoma Madroña" is on the hill east of the "warm springs," between the springs and Hodges hill. The road up the little cañon opposite the Bufford's passes near the tree. It has a diameter of about 8 feet 4 inches at the ground, 5 feet 1 inch at two feet from the ground, and 6 feet 8 inches at four feet. The diameter of the crown is 88 feet and it is fully 75 feet high.

At the summit of the Walker Valley-Willit's grade, is a tree 75 feet high and four feet in diameter at the smallest part of the trunk (three feet above the ground). Between Hawley School and Sherwood Valley, along the ridge, are many large trees; one is 65 feet high and 4 feet 5 inches in diameter at four feet above the ground. Many trees five to eight feet in trunk diameter at two to four feet from the ground are found in Mendocino County, but are almost invariably fire-hollowed. I recall many fine trees one hundred feet high along New River in Trinity County. Fine specimens grace the Indian School grounds in Hupa Valley, but some are dying. On the Trinity Summit trail is a tree 110 feet high, the perfect trunk three feet and six inches in diameter at five feet above the ground, typical of the fine trees in the northern region. On the trail to Cold Spring from Posts, Santa Lucia Mountains, is a tree, standing near a gate, seventy feet high and five feet in diameter at five feet from the ground. Brewer records a tree on Cave Hill, Marsh's Ranch, eastern side of Mt. Diablo, exposed ridge, the trunk six feet and nine inches in diameter at smallest place and branched seven or eight feet high. The tree on the point of hill at Novato station is striking in its port and isolation.

The two most common associates of Madroña are Black Oak and Douglas

Fir. It will, however, range into a country too arid for the Douglas Fir, as the Mt. Diablo Range and the Vaca Mountains, and it grows near the coast as in the Redwood Belt country shunned by the Black Oak.

Pure forests of Madroña are unknown, although over limited areas in the North Coast Ranges it forms 50 to 80 per cent. of the stand. Commonly it forms but 1 to 15 per cent. In its forest form it is an associate of the Tan Oak, Black Oak, Oregon Oak, Douglas Fir and Yellow Pine, but mixes with the Redwood in the Redwood Belt, and in Napa Valley it grows with Coast Live Oak, Bigleaf Maple, and Douglas Fir. It is more or less diverse in form, whether crowded or afforded free space, and most commonly develops a wide-spreading unsymmetrical or irregular crown. Young trees are usually symmetrical with oval crowns or rarely take on the conifer-like habit of Tan Oaks when associated with them in stands thirty to forty years old, as in southwestern Humboldt County. About Ashland, Oregon, adult trees are remarkably symmetrical and are called "Laurel." Very rarely one sees trees with erect branches simulating the habit of typical Digger Pine, as noticed by the author in northeastern Humboldt County.

The older the tree the more unsymmetrical, as a rule, and this is notably the case in mixed groves where Madroña growing alongside Tan Oak or Douglas Fir is invariably pushed to one side when coming into close competition for light with those species. Huge Madroña crowns developed wholly to one side of the trunk are very frequently met with. Or one may sometimes observe trunk and crown trailing along the ground because of an overbearing Tan Oak (which may in later years have disappeared). Another characteristic type is represented by a tree with a long slender trunk curving out twenty or thirty feet and up sixty or seventy feet to a wisp of a crown occupying in the forest canopy a small unpreempted area which would otherwise be a vacant patch of sky ten feet square or less. Such trees are remarkable for their tall trunks (which are often strongly flattened contrary to the direction of curve) and for their small crowns. On the other hand Madroña will come up under the protection of Black Oak and sometimes, as on the west side of Napa Valley, overtop it and finally kill it.

Reproduction is by means of stump sprouts and seeds. The seeds are twenty-five or thirty in each berry. Seedlings in the forest are in general uncommon, while stump sprouts are freely produced. The base of the stump bears beneath the bark conical woody buds capable of producing stump growths. If destroyed by storm or fire, or cut down by man, the tree is thus succeeded by vigorous sprouts and sometimes one finds a perfect circle of young saplings. Old trees usually have the trunk much enlarged or spreading horizontally at the ground, forming a low table-like base, so that the circles are sometimes very large. Madroña circles are, however, seldom so perfect as Redwood or Tan

Oak circles. Circles from adult trees show about ten to forty sprouts which grow two to six feet in height the first season.

Exfoliation of the bark takes place in June or July; at this time the new shoots begin to grow and the old leaves fall, littering the dry woods as thickly with dead leaves as if the season were late autumn. Sometimes the old leaves turn straight down and hang for a time in a crimson bunch beneath the erect new shoot. In the bud, the leaves are convolute, become plane on expansion and soon revolute, all before half-grown. The scales of the winter bud, which are homologous with blades, elongate on bursting, some of them becoming 1½ inches long.

The contrast of color in bark and foliage is the most striking feature of the tree to the traveler. On branches or young trunks the bark is deep red and very smooth. When the summer growth begins it is deciduous in thin layers, revealing a satiny ground of pale green which ages into the characteristic red or terra-cotta bark. On old trunks the bark becomes dark brown in color, no longer exfoliates in layers, but checks into squarish scales about one-half inch across which are very friable. The bark parts readily from the wood, and girdled trunks, girdled without apparent provocation or as mere pastime, are often seen in the forest. Their color and smoothness, so attractive to some, seem but a challenge to the destructive instincts of others. Fortunately the bark generally retains a thin layer next the wood which the vandal ignorantly overlooks and the tree often lives and flourishes in spite of mutilation.

The wood is close-grained, heavy, hard and strong, but checks badly in seasoning and is attacked by borers, down logs in the forest being promptly honeycombed by them. It is used for fuel, for the manufacture of furniture and wooden stirrups of the California sort, and is also converted into charcoal which is used for fuel or in making gunpowder. For the manufacture of gunpowder its charcoal is so much superior to other charcoal that the virgin bodies of Madroña have been largely cut in the Santa Cruz Mountains and second-growth is now being used.

The berries when fully ripe are sweetish, very slightly acid and not unpalatable even to the white man. Either cooked or uncooked they formed one of the food resources of the native tribes and were with them an esteemed article of diet. The wild pigeons, too, live on them for a season, a fact known to hunters who resort to their feeding grounds in November when the berries are fully ripe.

*Arbutus Menziesii* has a special historical interest in that in collection and publication it nearly antedates any other Californian trees.[59] It was first published by Pursh in his Flora of North America in 1814 and first collected

[59] The only earlier species are *Quercus agrifolia* Neé and *Quercus lobata* Neé, collected at Monterey in 1790 and published at Madrid in 1801. Neé's paper is the first publication to contain descriptions of Californian trees. Pursh's Flora is the second.

in 1791 by Archibald Menzies, the first botanist after Haenke to make a collection of Pacific Coast trees. Menzies, while attached to the Vancouver Expedition, discovered it on the "northwest coast of America." No more exact locality has been known for the Menzies specimens, but an examination of the type in the British Natural History Museum in London discloses on the back of the sheet the legend "New Georgia, Mr. Menzies." It was, therefore, most probably collected on the shores of Puget Sound or on Vancouver Island, although Menzies must have seen it also in the Santa Cruz Mountains, where he collected the Coast Redwood and other California trees. Although he was the first botanist to collect specimens, the tree had previously been known to the Spanish Californians who transferred to it the name of the Arbute-tree of Spain, Madroña.

As an ornamental tree this species should make a strong appeal to Californians. In some places where it stands naturally it has been jealously preserved and as the ease of propagation becomes known it will, doubtless, be more commonly planted. Seeds germinate readily in open-air nursery beds and for cultivation plants should be obtained in this way or from nursery stock, as the transplanting of seedlings from the forest is attended with uncertainty. The most favorable month to transfer forest seedlings is July or August.

That Madroña has thus far no place in California gardens is partly to be explained by the unhappy preference for exotics and because the tree as it grows in its native woods is little known to the people. For beyond any peradventure of doubt it is the most handsome tree in California and enlivens the forest and groves with its unrivaled woodland colors. Of slight economic importance as a timber species, it is in every other way a notable tree. Its crown of flowers and masses of crimson berries, its burnished foliage and terra-cotta bark, its manner of branching and habits of growth are alike full of interest and of charm.

## OLEACEAE. Ash Family.

Trees or shrubs mostly with opposite leaves. Flowers small, commonly in panicles, mostly unisexual. Stamens few. Ovary superior, 2-celled; style one. Fruit a samara, capsule or drupe.—An interesting family, which includes the Forsythia, Lilac, Olive, and Privet, all cultivated with us.

### 1. Fraxinus L. Ash.

Trees or shrubs. Leaves pinnately compound (except one species), deciduous; terminal leaflet on a longer stalk than the lateral or the lateral leaflets sessile. Flowers in small panicles, appearing just before the leaves and from separate buds. Corolla with 2 equal petals or none. Stamens 2 (rarely 1 or 3). Ovules 2 in each cell. Fruit a 1-seeded samara, with terminal wing.—About thirty species, northern hemisphere, mainly north temperate.

KEY TO THE SPECIES.

Trees; corolla none; style conspicuously 2-lobed.

Flowers dioecious; leaves pinnate; leaflets 2 inches long or more; branchlets terete.

Leaflets oblong to oval, the lateral commonly sessile; cismontane ..... 1. *F. oregona.*

Leaflets round-ovate, the lateral leaflets on petioles ¼ to ½ inch long; desert ranges ..... 2. *F. coriacea.*

Leaflets lanceolate, the lateral with petioles 1 line long; desert area ..... 3. *F. velutina.*

Flowers polygamus; leaves simple, rarely with 2 or 3 leaflets; branchlets of the season 4-sided; desert area ..... 4. *F. anomala.*

Shrubs; corolla present; flowers perfect; style obscurely lobed; leaflets mostly stalked, less than 2 inches long; branchlets of the season strongly 4-sided; cismontane ..... 5. *F. dipetala.*

## 1. **Fraxinus oregona** Nutt.

### OREGON ASH.

FRAXINUS OREGONA Nuttall, Sylva, vol. 3, p. 59, pl. 99 (1849); Cooper, Pac. R. Rep., vol. 12, pt. 2, pp. 28, 68 (1860); Gray, Bot. Cal., vol. 1, p. 472 (1896), Syn. Fl., vol. 2, pt. 1, p. 76 (1878); Kellogg, For. Trees Cal., p. 88 (1882); Sargent, Silva N. Am., vol. 6, p. 57, t. 276 (1894); Parish, Zoe, vol. 4, p. 344 (1894); Jepson, Fl. W. Mid. Cal., p. 385 (1901).

Tree 30 to 80 feet high with a trunk diameter of ½ to 3 feet; trunk bark one-sixth to ¾ inch thick, gray-brown, fissured into narrow freely interlaced ridges; leaves 6 to 12 inches long; leaflets 5 to 7, oblong to oval, or often broadest toward the apex and abruptly short-pointed, the margin entire or with rounded teeth above the middle, finely soft hairy when young, especially on the under surface, 2 to 5½ inches long, the terminal leaflet largest; flowers borne in small crowded clusters, destitute of petals; calyx of staminate flower very small and abruptly cut off, with 2 (sometimes 1 or 3) stamens; calyx of pistillate flower toothed, shorter than the ovary and persistent; samara oblong-lanceolate, 1¼ to 2 inches long, including the wing, the body clavate and ½ to ¾ inch long.

The Oregon Ash borders streams in valleys and mountain cañons. It is distributed throughout the North Coast Ranges, Sacramento and San Joaquin valleys and Sierra Nevada and extends northward to British Columbia. In Southern California it occurs in a few localities in the Sierra Madre, San Bernardino and San Jacinto ranges, finding its southernmost home near Warner Hot Springs in San Diego County. In the South Coast Ranges it is comparatively rare, but I have observed it on Carnadero Creek, just south of Gilroy.[60] The highest station is the northern base of the San Bernardino Mountains, 4000 feet, recorded by Parish; the lowest, the banks of the lower Sacramento River, two or three feet above tide water, by the author. It was first collected by Thomas Nuttall in Oregon in 1834.

[60] It also occurs in the Santa Cruz Range and at Walnut Creek.

Great quantities of fruit are produced and held into the winter or partially over one year. Sprouts arise freely from cut stumps. Tent caterpillars sometimes denude the trees of foliage. Along Porter Creek in eastern Sonoma County I saw in May, 1904, trees with no foliage save the white midribs of the compound leaves sticking stiffly out all over them.

The wood is heavy, hard, coarse-grained and strong, and in western Oregon and Washington is used for wagon-making, implement handles, oars, furniture, and interior finish. Sparsely scattered along water-courses and becoming less frequent in the drier parts of the State it is, however, of little forestral importance in California except locally in the North Coast Ranges, where in a few localities it is common in inundated areas in valleys or in river bottoms. The wood on account of its toughness is sometimes used by ranchmen in the southern Sierras for making single-trees and wagon-poles, but never the second time, as borers promptly riddle it.

### 2. **Fraxinus coriacea** Wats.

LEATHER-LEAF ASH.

FRAXINUS CORIACEA Watson, Am. Nat., vol. 7, p. 302 (1873); Rothrock, Bot. Wheeler, p. 185, pl. 22 (1878); Coville, Bot. Death Val. Exped., p. 148 (1893).

Tree 20 to 30 feet high with round-topped crown and rough gray trunk; leaves compound, pale green, glabrous and 3 to 6 inches long; leaflets 5 to 7, round ovate to elliptic or oblong, mostly abruptly pointed, 1½ to 3 inches long; petiole of lateral leaflets ¼ to ½ inch long, of terminal leaflet 1 inch long; margin entire or with minute scattered teeth; samaras 1 inch long with wings 1½ to 2 lines wide.

Leather-leaf Ash inhabits the desert regions from southern Utah to southeastern California; in the latter region it occurs on the east side of Owens Lake and at the east base of Mt. San Jacinto (2000 feet altitude). The type specimens were collected at "Ash Meadows, Nevada, *Wheeler,* and Devil's Run Cañon, Arizona, *Bigelow.*"

### 3. **Fraxinus velutina** Torr.

ARIZONA ASH.

FRAXINUS VELUTINA Torrey, Emory's Rep., p. 149 (1848); Sargent, Silva N. Am., vol. 6, p. 41, t. 267 (1894), in part.

*Fraxinus pistaciaefolia* Torrey, Pac. R. Rep., vol. 4, p. 128 (1856), Bot. Mex. Bound. Sur., p. 166 (1858).

Tree 15 to 30 feet high with grayish somewhat fissured bark; leaves compound; leaflets 5, lanceolate, 2½ to 4 inches long, ½ to ⅞ inch wide, green above, yellowish green beneath, mostly entire; petioles of lateral leaflets 1 line long, of terminal leaflet ½ inch long; samaras 1 inch long, the wing 2 lines wide.

Arizona Ash inhabits the banks of streams in cañons or the borders of lakes or springs. It is distributed from western Texas to southern Nevada, ranging west to the Panamint Mountains and Owens Lake in southeastern California, recurring at the southwestern base of Mt. San Jacinto at 2200 feet. It is remarkable for its willow-like leaflets. The original specimens were collected by Lieutenant W. H. Emory in the region between the Rio Grande and Gila River.

### 4. **Fraxinus anomala** Wats.

DWARF ASH.

FRAXINUS ANOMALA Watson, Bot. King., p. 283 (1871); Gray, Syn. Fl., vol. 2, pt. 1, p. 74 (1878); Coville, Bot. Death Val. Exped., p. 148 (1893); Sargent, Silva N. Am., vol. 6, p. 39, t. 266 (1894).

Tree 15 to 20 feet high, or a low spreading shrub; leaves simple, roundish or broadly ovate, the margin with small and rather remote teeth, 1½ to 2 inches long, or compound with 2 or 3 similar leaflets; flowers either perfect or pistillate, both forms occurring in the same cluster; samara 8 or 9 lines long, with a rounded wing which surrounds the body and is 4 to 5 lines broad.

The Dwarf Ash grows in the Providence and Charleston mountains in the Death Valley region, thence eastward to southern Utah, western Colorado and northern Arizona. It was first collected by Dr. J. S. Newberry in Labyrinth Cañon of the Colorado River in Utah in 1859.

5. **Fraxinus dipetala** H. & A. FLOWERING ASH. Shrub 5 to 15 feet high; leaves 2 to 6 inches long; leaflets 3 to 9, serrate above the middle, ¾ to 1½ inches long; petals 2, white, about 3 lines long; samaras 1 to 1¼ inches long, the wing frequently notched at tip.

Cañon sides throughout the State excepting in the desert region. I have not elsewhere seen it so abundant as in the South Coast Range region between Priest Valley and San Benito Peak. The one-year-old shoots are conspicuously four-sided and four-winged, but eventually become terete and wingless.

## BIGNONIACEAE. BIGNONIA FAMILY.

Trees or shrubs, the leaves most frequently opposite and compound. Flowers large and showy, perfect, bilabiate. Stamens 4 in 2 pairs, the fifth stamen sterile or wanting. Ovary 2-celled, style 1; stigma 2-lobed. Valves of the fruit 2, falling away from the placentiferous partition and releasing usually winged seeds.—Large tropical order containing many lianes. Species of Bignonia, Tecoma and Catalpa are in garden cultivation.

### 1. Chilopsis Don.

Leaves simple, deciduous. Flowers in a terminal raceme, with funnelform corolla, ventricose above, the ample limb bilabiate, 5-lobed. Stamens 4 and a sterile filament, the anther-cells glabrous and diverging. Capsule long, linear, terete. Seeds oblong, thin, with the wing at each end replaced by a tuft of soft hairs.—One species.

#### 1. **Chilopsis saligna** Don.

Desert Willow.

Chilopsis saligna Don, Edin. Phil. Jour., vol. 9, p. 261 (1823); Gray in Bot. Cal., vol. i, p. 587 (1876).

Chilopsis linearis DeCandolle, Prodr., vol. 9, p. 227 (1845); Sargent, Silva N. Am., vol. 6, p. 95, t. 292 (1894).

Slender willow-like shrub or tree 10 to 25 feet high with trunk 3 to 8 inches in diameter; leaves opposite, whorled or mostly irregularly alternate, linear with lanceolate apex, entire, 1½ to 3 lines wide, 2 to 5 inches long, slightly glandular when old; corolla white and purplish, blotched with yellow in throat, 1 to 1¼ inches long, its rounded spreading lobes erose and undulate; capsule 6 to 12 inches long and 2 lines broad, with oblong thin seeds 4 lines long.

The Desert Willow grows along water-courses or washes in the Mohave and Colorado deserts of Southern California, westward to San Jacinto Valley, southward into Lower California and northern Mexico, and eastward through southern Nevada and Arizona to western Texas. Its willow-like habit and showy flowers make it an interesting feature of the desert flora.

## CAPRIFOLIACEAE. Honeysuckle Family.

Small trees or shrubs with opposite leaves. Flowers complete. Calyx-tube adnate to the ovary, the toothed limb insignificant. Corolla tubular or rotate, 4 or 5-lobed, regular or irregular. Stamens inserted on the corolla, as many as its lobes. Ovary 2 to 5-celled; style one. Fruit in ours a berry or berry-like drupe.

### 1. Sambucus L. Elder.

Shrubs or small trees with odd-pinnate leaves and serrate leaflets. Flowers small, white, in a terminal compound cyme, jointed with their pedicels. Calyx 5-toothed. Corolla regular, rotate, deeply 5-lobed. Ovary 3 to 5-celled; style short; stigmas 3 to 5; ovules solitary, suspended from the summit of each cell. Fruit small globose berry-like drupes, with cartilaginous nutlets.—Twenty species, represented in every continent except Africa.

KEY TO THE SPECIES.

Inflorescence flat-topped; berries black-purple with a blue bloom ..... 1. *S. glauca.*
Inflorescence ovate in outline; berries red ..... 2. *S. racemosa.*

## 1. **Sambucus glauca** Nutt.

BLUE ELDERBERRY.

Plate 84.

SAMBUCUS GLAUCA Nuttall, in Torrey and Gray, Fl. N. Am., vol. 2, p. 13 (1841);[61] Gray, in Bot. Cal., vol. 1, p. 278 (1876); Sargent, Silva N. Am., vol. 5, p. 91, t. 222 (1893); Jepson, Fl. W. Mid. Cal., p. 471 (1901).

In typical adult form a tree 15 to 28 feet high with a trunk clothed in dark roughly fissured bark and commonly ½ to 1½ feet in diameter; usually a bush with several to many upright stems; leaves compound with 5 to 7 leaflets; leaflets coriaceous, glabrous, ovate to oblong-lanceolate, serrate except at the abruptly acuminate apex, 1 to 4 inches long; flowers small (2½ to 3½ lines broad), aggregated in a terminal flat-topped cluster 2 to 6 inches broad, consisting of one or several 5-rayed cymes; berry 2 lines in diameter, blue beneath the white bloom.

The Blue Elderberry ranges from Washington to Southern California[62] and eastward to Nevada. While its small bush-like cluster of stems may aspire to develop one tree-like trunk, it is rarely that they do so, for the tree form in a forestral sense is very uncommon. Even in bush form it is not gregarious but disposed to be solitary. This is the more remarkable in that reproduction is amply provided for. Every trunk stump-sprouts freely, often without any obvious stimulus, such as would result from mutilation. Such shoots grow four to fifteen feet in length in one season. Berries, moreover, are produced in great quantity and the seeds are widely dispersed by birds.

The wood is soft, light, not strong and is valued little by the white man. When the trunks are large enough for the purpose they last well as posts. The native tribes used the straight shoots for the shafts of their arrows. The berries are esteemed in rural cookery. The brewed bark is a folk remedy for

[61] Fritz Graf von Schwerin in his Monograph of the Genus Sambucus (Mitt. der Deut. Dendrol. Gesellschaft, no. 18), a very interesting paper, replaces the long-accepted name, *Sambucus glauca* Nutt., by the name *Sambucus coerulea* Rafinesque (Alsographia americana, p. 48, 1838). This monograph is received too late to determine to what degree its new results may be applied to the species of our region.

[62] SAMBUCUS MEXICANA DC. The Mexican Elder, which is in general similar to *Sambucus glauca* Nutt. but has lustrous black fruit without bloom, is credited to southern California and Plumas County by Sargent (Trees N. Am., p. 806) and by Sudworth (For. Trees Pac. Slope, p. 435). In this they seem to follow Gray (Syn. Fl., vol. 1, pt. 2, p. 9). On the contrary I attach great weight to the judgment of Mr. Parish, who has been for several decades a close and careful student of the flora of Southern California. He makes the express statement (Zoe, vol. 4, p. 344) that he has been unable to verify its occurrence in Southern California. It may be noted further that *Sambucus glauca* is the only species recognized by Abrams in his Flora of Los Angeles and Vicinity (p. 380).

dropsy, while the flowers were steeped as a fever remedy by the native tribes of Southern California.

The largest tree measured by the author is at Glenbrook, Lake County. In 1897 it was two feet four inches in diameter at two feet above the ground. Two limbs are given off at 4.6 feet above the ground, being respectively one foot ten inches and one foot six inches in diameter. The height of the tree was twenty-two feet. On the North Fork of the Kaweah at Davis Ranch is a tree one foot three inches in diameter at four feet above the ground and eighteen feet high. A group in a field south of Talmage near Ukiah are twenty-five to twenty-eight feet high with trunks one foot in diameter.

In late summer *Sambucus glauca* is an unattractive, scraggly tree on account of its habit of dying back and its thicket-like growth. Its best season is spring, when the full-foliaged round-headed clumps are highly attractive, as they are also a few months later when dowered with flowers.

2. **Sambucus racemosa** L. var. **callicarpa** Jepson. RED ELDERBERRY. (Plate 85.) A many-stemmed shrub or sometimes in bottom lands near the sea becoming distinctly arborescent, 12 to 25 feet high and with a trunk 4 to 6 inches in diameter; leaflets 5 to 7, thin, oblong or obovate, abruptly acuminate, sharply serrate to the very apex, 2½ to 7½ inches long, 1 to 3 inches wide; petioles, midribs and veins on sterile shoots short hirsute, especially late in the season; flowers white in a thyrsoid-like panicle which is ovate in outline and 2 to 3 inches high; berries red, 2½ to 3 lines long.

The Red Elderberry grows on flats of the ocean shore from Bolinas Bay in California northward to Washington, only a few feet above sea-level. There are fine examples near Inverness in Marin County and at Usal in Mendocino County, at ten feet above sea-level. Covered in June with their bright clusters of red berries they present a handsome and attractive appearance. This species stump-sprouts freely. I have measured sprouts, one season's growth, thirteen feet long. The species, *Sambucus racemosa,* occurs in the high Sierra Nevada as a shrub.

PLATE 1.

## EXPLANATION OF PLATE 1.

*Quercus lobata* Neé (Valley Oak). Straight-limbed white-barked type of tree on clay lands of the San Antonio River Valley, Monterey County. Pages 13, 204, 205.

Photograph by W. L. Jepson and B. F. White.

*Quercus lobata* Née.

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PLATE 2.

## EXPLANATION OF PLATE 2.

Typical "Bald Hills" country of Mendocino and Humboldt counties. Mixed growth of *Pseudotsuga taxifolia* Britt. (Douglas Fir), *Pasania densiflora* Oerst. (Tan Oak), *Arbutus Menziesii* Pursh (Madroña), *Quercus Kelloggii* Newb. (Black Oak), *Quercus Garrayana* Dougl. (Oregon Oak), with open glades and bare shoulders between the groves. California Laurel in middle foreground. Tan Oak recognized by its light color. (Near Briceland, Humboldt County, altitude 2500-3000 feet.) Pages 16, 210, 236, 273.

Photograph by W. L. Jepson and B. F. White.

Mixed Growth in the North Coast Ranges.

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PLATE 3.

## EXPLANATION OF PLATE 3.

*Quercus Douglasii* H. & A. (Blue Oak). Typical scattered growth in the Sierra Nevada foothills. (Near Three Rivers, Tulare County, trees 25 to 40 feet high, trunk diameter ½ to 2 feet.) Seasonal precipitation about 16 inches. Pages 19, 214.

Photograph by W. L. Jepson and B. F. White.

*Quercus Douglasii* H. & A.

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PLATE 4.

## EXPLANATION OF PLATE 4.

Typical forest stand bordering a Big Tree meadow in the Sierra Nevada, consisting of, (*a*) *Sequoia gigantea* Dec. (Big Tree), tree past maturity, (*b*) typical mature round-topped tree; (*c*) *Abies concolor* Gord. & Lindl. (Red Fir), *Pinus ponderosa* Dougl. (Yellow Pine) in background; and (*d*) *Pinus Lambertiana* Dougl. (Sugar Pine). (Round Meadow, Giant Forest, altitude 6500 feet.) Pages 19, 70, 77, 142.

Photograph by W. L. Jepson and B. F. White.

Grove of *Sequoia gigantea* Dec.

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PLATE 5.

## EXPLANATION OF PLATE 5.

Sierra Nevada timber-line forest on glacial country, consisting of *Pinus albicaulis* Engelm. (White-bark Pine), *Pinus Murrayana* Balf. (Tamrac Pine), and *Pinus Balfouriana* Murr. (Fox-tail Pine). (Between Kearsarge Pass and Kearsarge Pinnacles, altitude 11,000-11,500 feet; trees 5 to 25 feet high.) Pages 19, 73, 82.

Photograph by W. L. Jepson and B. F. White.

Subalpine Forest in the Sierra Nevada.

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PLATE 6.

## EXPLANATION OF PLATE 6.

*Washingtonia filifera* Wendl. (Washington Palm). "Thousand Palms," one of the stations for this species in the Colorado Desert (five miles northwest of Indio), showing the desert scenery, scattered growth, and pendulous fruit clusters. Seasonal precipitation at this station averages 2.43 inches, the range being from 0.0 to 6.47 inches. Maximum temperatures, May-October, 101°-125°; minimum temperatures, November-April, 20°-47°. Pages 20, 172.

Photograph by C. C. Pierce.

*Washingtonia filifera* Wendl. in the Colorado Desert.

(Copyrighted by C. C. Pierce & Co., Los Angeles, Cal., 1903.)

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PLATE 7.

## EXPLANATION OF PLATE 7.

*Pasania densiflora* Oerst. (Tan Oak). Typical broad-crowned tree of the open woods of the "Bald Hills" country of Mendocino and Humboldt counties. (Near Ukiah, altitude about 2000 feet.) Pages 17, 37, 236.

Photograph by A. O. Carpenter.

*Pasania densiflora* Oerst.

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PLATE 8.

## EXPLANATION OF PLATE 8.

*Pinus Murrayana* Balf. (Tamrac Pine). Wind-controlled tree, Desolation Valley, Sierra Nevada, region of Lake Tahoe, altitude 8000 feet. Windward branches mechanically massed to leeward, resulting in unilateral crown. Curve at base of some of the windward branches plainly obvious, although doubtless some windward branches were killed in the bud or later by wind desiccation. Pages 40, 81.

Photograph by W. A. Setchell.

Effect of wind on *Pinus Murrayana* Balf.

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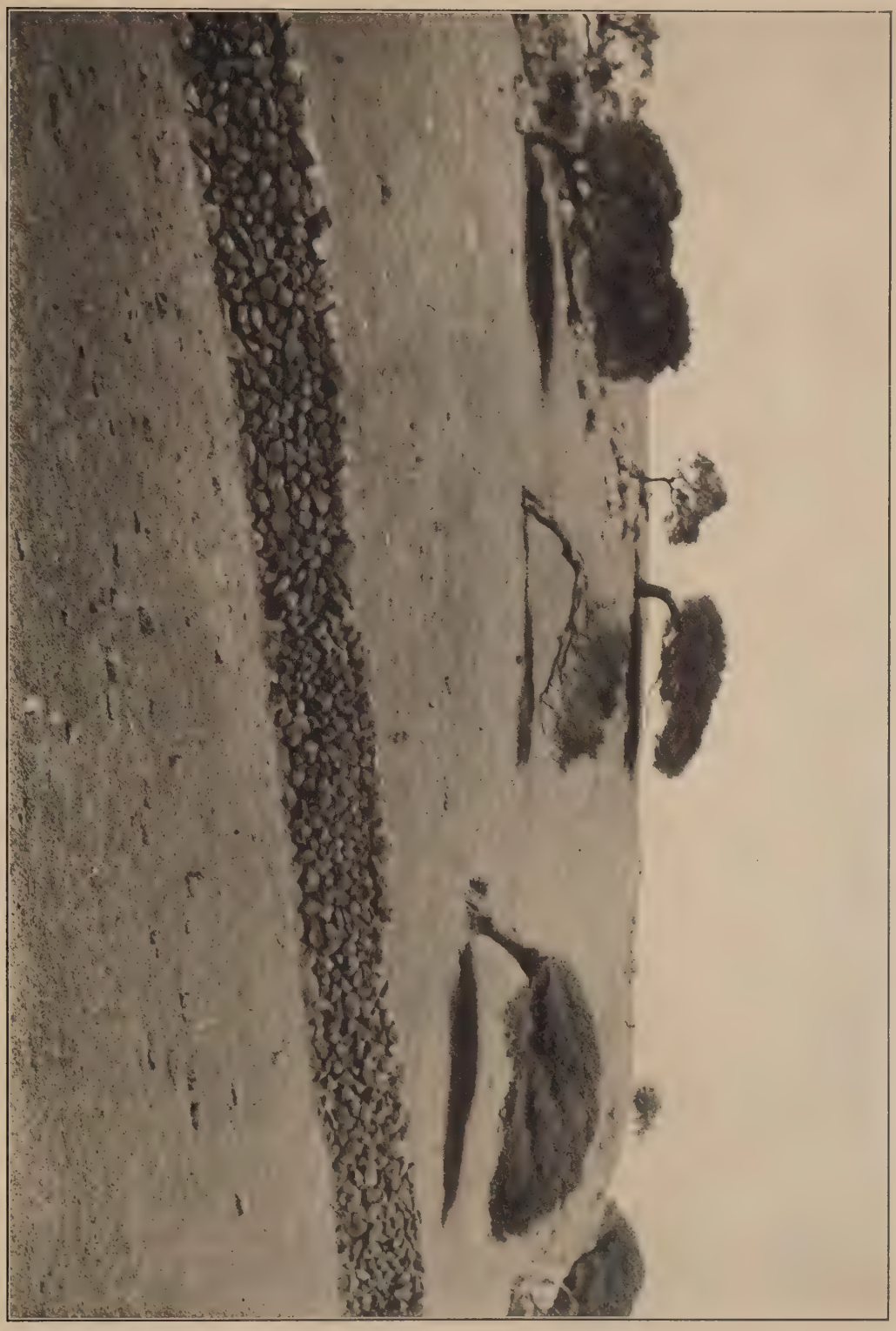
PLATE 9.

## EXPLANATION OF PLATE 9.

Wind-controlled *Quercus agrifolia* Neé (Coast Live Oak). Colony of trees in a wind-gap in the Napa Range near Cordelia, Solano County. Average hourly wind velocity during prevalence of afternoon trade winds, April-August (which is also the growing season), estimated 10-20 miles per hour; estimated maximum velocity, 40-50 miles per hour. Height of trees, 8 to 12 feet. Pages 40, 42, 226.

Photograph by W. L. Jepson and B. F. White.



Effect of wind on *Quercus agrifolia* Neé.

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PLATE 10.

## EXPLANATION OF PLATE 10.

Wind-controlled colonies of *Umbellularia californica* Nutt. (California Laurel).

Fig. 1. Colonies in a cañon and side gulches on the south side of Mt. Tamalpais, the slope of the hill prolonged over the "wind-shorn" trees.

Photograph by G. K. Gilbert.

Fig. 2. Large clump near Olema, Marin County; prevailing wind at this station northwest, maximum velocities (estimated), 30 to 70 miles per hour, attained many times a month, and at least once a month usually. Pages 41, 42, 243.

Photograph by W. L. Jepson.

1

2

Wind-controlled Clumps of *Umbellularia Californica* Nutt.

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PLATE 11.

## EXPLANATION OF PLATE 11.

Wind-controlled *Cupressus macrocarpa* Hartw. (Monterey Cypress) on Monterey coast.

Fig. 1. Trees 45 feet high near beach at Cypress Point, showing dense masses of foliage and board-like main branches.

Fig. 2. Tree with depressed crown and partially exposed root-system, on sea-cliffs at Point Lobos. With the eating away of the cliffs this tree will eventually go into the ocean, following the fate of many predecessors. Pages 37, 41, 155.

Fig. 2 is a photograph by L. E. Hunt.

1

2

*Cupressus macrocarpa* Hartw.

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PLATE 12.

## EXPLANATION OF PLATE 12.

Wind-controlled *Sequoia sempervirens* Endl. (Redwood). Trees on low sandy beach within about 500 yards of the ocean near Inglenook, Mendocino coast. Prevailing winds northwest. Page 42.

Photograph by W. L. Jepson and B. F. White.

Wind-controlled *Sequoia sempervirens* Endl.

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PLATE 13.

## EXPLANATION OF PLATE 13.

Wind-controlled *Pinus muricata* Don (Bishop Pine). Trees in a wind-gap of the hills of the Point Reyes Peninsula. All the old branches have been torn from the trees by high gales, except those directly to leeward, which therefore stand in one plane; crown formed of younger, somewhat flexible branches; prevailing wind direction northwest; maximum wind velocities about 50-84 miles per hour. (Estimate based on nearest recording station, 18 miles distant.) Pages 42, 96, 99.

Photograph by W. L. Jepson and B. F. White.

*Pinus muricata;* trees in a wind-gap.

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PLATE 14.

## EXPLANATION OF PLATE 14.

*Quercus lobata* Neé (Valley Oak). Rejuvenated individual ("second youth stage"); the original crown lost by dry rot. The new main branches are erect and straightish instead of crooked, but restoring original outline of tree and displaying the pendulous cords. Seasonal precipitation, 27 inches. Monthly temperatures, absolute maximums, drought season, May-October, 86°-115°; absolute minimums, wet season, November-April, 22°-44°. Nearest recording station, ½ mile distant (Vacaville, Solano County). Pages 11, 32, 44, 204, 205.

Photograph by W. L. Jepson and B. F. White.

*Quercus lobata* Neé on a valley floor.

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PLATE 15.

## EXPLANATION OF PLATE 15.

*Pinus Lambertiana* Dougl. (Sugar Pine). Figure 1, opened cone with peduncle; fig. 2, seed. (Material from Sequoia National Park.) Page 70.

*Pinus monticola* Don (Silver Pine). Figure 3, opened cone; fig. 4, closed cone; fig. 5, seed. (Material from Soda Cañon near Sawtooth Range.) Page 69.

All figures natural size. Figures 1 and 2 drawn by Mary H. Swift, figs. 2 and 4 by A. J. Heindl, fig. 5 by Eloise Roorbach.

*Pinus Lambertiana* Dougl. and *Pinus monticola* Don, types of California white pines.

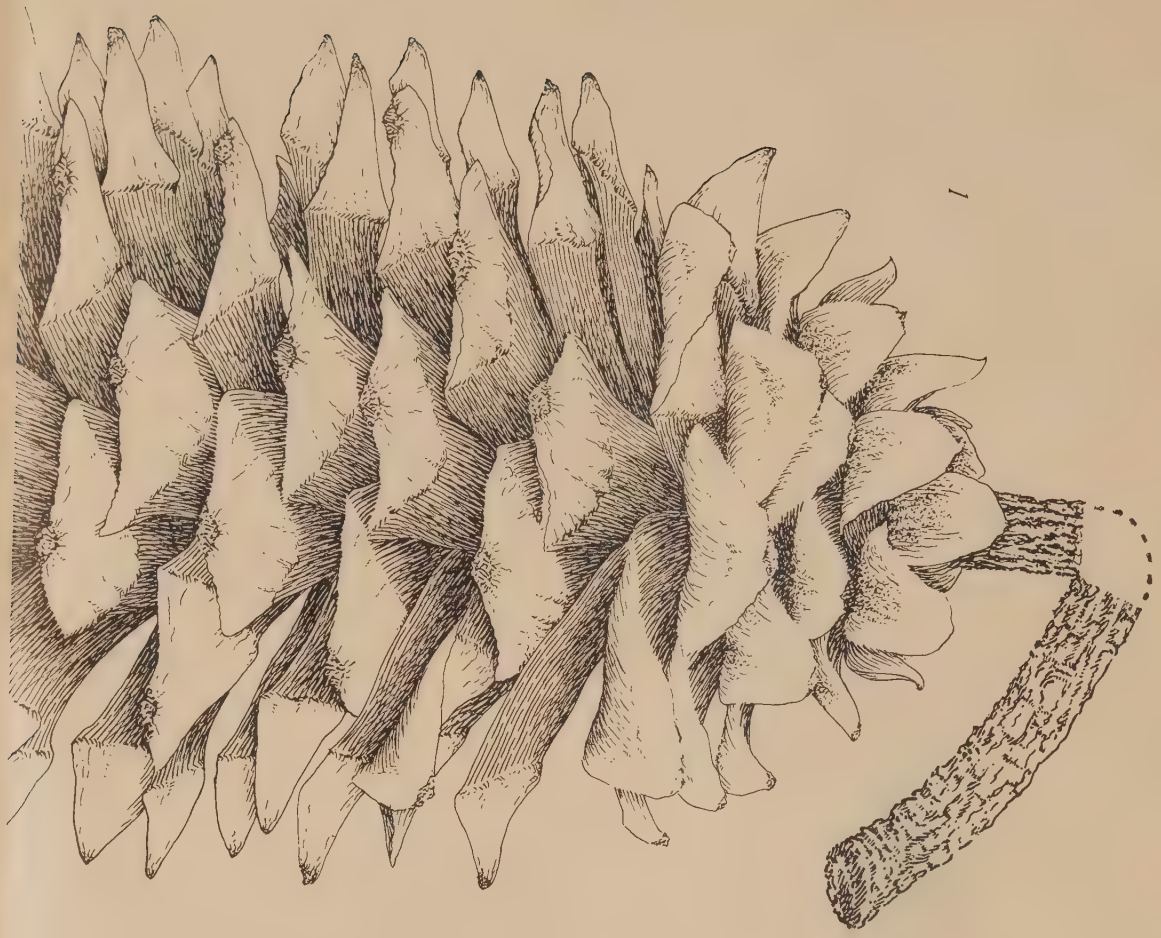

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PLATE 16.

## EXPLANATION OF PLATE 16.

*Pinus albicaulis* Engelm. (White-bark Pine). Figure 1, cone; fig. 2, seed. (Material from Kearsarge Pass.) Page 73.

*Pinus flexilis* James (Limber Pine). Figure 3, cone; fig. 4, seed. (Material from El Toro Peak.) Page 74.

*Pinus Balfouriana* Murr. (Foxtail Pine). Figure 5, cone; fig. 6, seed. (Material from Little Claire Lake, Sawtooth Range.) Page 75.

All figures natural size. Figures 1, 2, 4, and 6 drawn by A. J. Heindl, fig. 3 by Eloise Roorbach, fig. 5 by Mary H. Swift.

*Pinus albicaulis* Engelm., *Pinus flexilis* James, and *Pinus Balfouriana* Murr.; high montane pines.

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PLATE 17.

## EXPLANATION OF PLATE 17.

*Pinus albicaulis* Engelm. (White-bark Pine). Depressed or table-like individuals, the crown 2 to 3 feet high and 4 to 8 broad; one of the characteristic forms of the species at timber line in the Sierra Nevada, especially in cirques or on flats where the snow accumulates 10 to 100 feet in depth during the winter. (Cirque just below Kearsarge Pass, southern Sierra Nevada, east slope. 11,500 feet altitude.) Pages 19, 73, 74.

Photograph by W. L. Jepson and B. F. White.

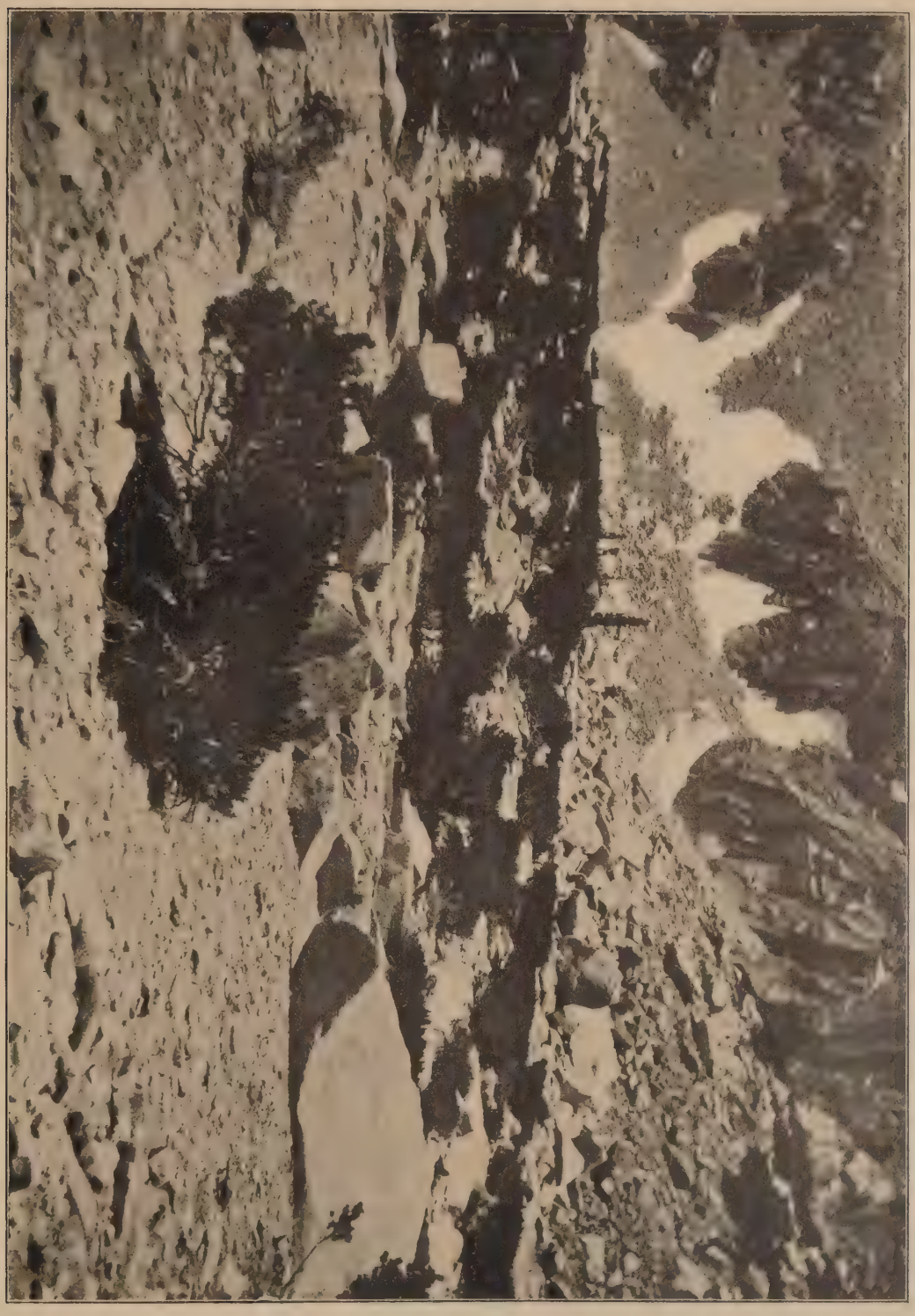

Table-like crowns of *Pinus abicaulis* Engelm.

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PLATE 18.

## EXPLANATION OF PLATE 18.

*Pinus flexilis* James (Limber Pine). Characteristic thin but pure stand, summit of El Toro Peak, one of the peaks of Santa Rosa Mountain in the San Jacinto Range, Southern California. 8300-8705 feet altitude. Trees 20 to 50 feet high, trunk diameter 1 to 3 feet, crown becoming flat-topped in age as shown in left foreground. Pages 74, 75.

Photograph by W. L. Jepson and B. F. White.

*Pinus flexilis* James, crowning a desert mountain.

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PLATE 19.

## EXPLANATION OF PLATE 19.

*Pinus Balfouriana* Murr. (Foxtail Pine). Typical individual near timber line, with excessively thickened trunk, small crown, and dead splinter summit to the axis; 55 feet high and 4 feet trunk diameter. (Quinns Pass, Sawtooth Range, Sierra Nevada, altitude 11,000 feet.) Pages 40, 75.

Photograph by W. L. Jepson.

*Pinus Balfouriana* Murr. at timber-line.

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PLATE 20.

## EXPLANATION OF PLATE 20.

*Pinus ponderosa* Dougl. (Western Yellow Pine). Figure 1, opened cone; the missing scales at base of cone persisted on the branch when the cone fell; fig. 2, seed. (Material from Sequoia National Park.) Page 77.

*Pinus contorta* Dougl. (Beach Pine). Figure 3, cone; fig. 4, seed. (Material from Mendocino coast.) Page 83.

*Pinus Murrayana* Balf. (Tamrac Pine). Figure 5, cone; figure 6, seed. (Material from Bubbs Creek, southern Sierra Nevada.) Page 81.

All figures natural size. Figures 1 and 5 drawn by Mary H. Swift, figs. 2, 3, and 4 by Eloise Roorbach, fig. 6 by A. J. Heindl.

*Pinus ponderosa* Dougl.; *Pinus contorta* Dougl.; *Pinus Murrayana* Balf.

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PLATE 21.

## EXPLANATION OF PLATE 21.

*Pinus ponderosa* Dougl. var. *Jeffreyi* Vasey (Jeffrey Pine). Typical tree at high altitudes, especially southward, characteristically flat-topped, past maturity, 45 feet high and 2 feet trunk diameter (Mt. San Jacinto, altitude 8500 feet.) Page 80.

Photograph by W. L. Jepson and B. F. White.

*Pinus ponderosa* Dougl. var. *Jeffreyi* Vasey.

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PLATE 22.

## EXPLANATION OF PLATE 22.

*Pinus ponderosa* Dougl. var. *Jeffreyi* Vasey (Jeffrey Pine). Typical red-brown trunk; in background thin forest of *Abies concolor* Lindl. & Gord. (White Fir) and *Pinus Murrayana* Balf. (Tamrac Pine). (San Jacinto Mountain, altitude 8000 feet.) Page 80.

Photograph by W. L. Jepson and B. F. White.

*Pinus ponderosa* Dougl. var. *Jeffreyi* Vasey.

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PLATE 23.

## EXPLANATION OF PLATE 23.

*Pinus Murrayana* Balf. (Tamrac Pine). Characteristic pure stand bordering a Sierra Nevada meadow or wet swamp, the trees 40 to 100 feet high and 1 to 3 feet in trunk diameter. (Williams Meadows, South Kings River-Giant Forest trail.) Pages 81, 82.

Photograph by W. L. Jepson and B. F. White.

*Pinus Murrayana* Balf.

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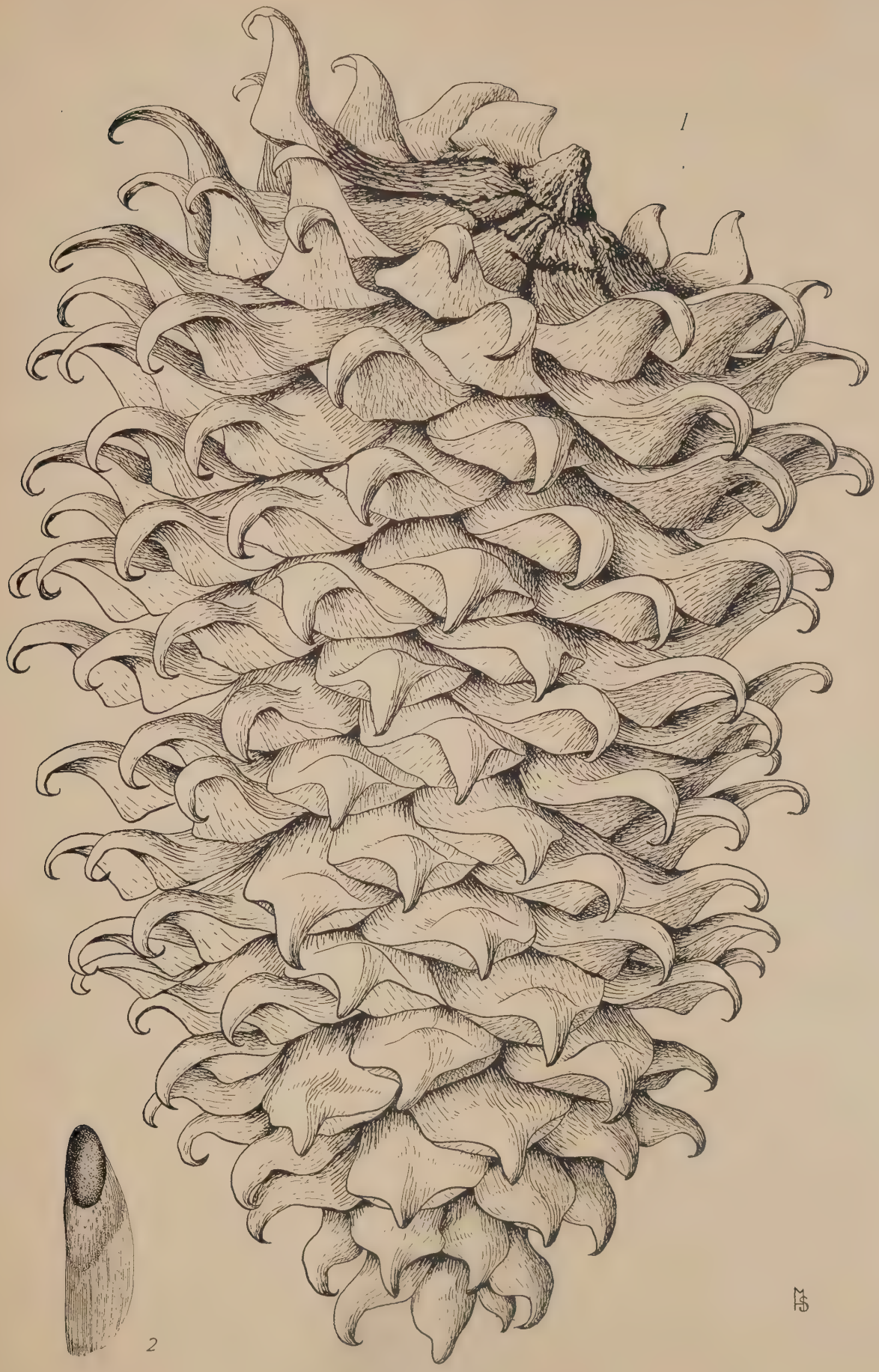
PLATE 24.

## EXPLANATION OF PLATE 24.

*Pinus Coulteri* Don (Big-cone Pine). Figure 1, cone; fig. 2, seed. Cone from Mt. San Jacinto; seed from Mt. Diablo.) Page 84.

Figure 1 drawn by Mary H. Swift, fig. 2 by Louise Nash.




*Pinus Coulteri* Don.

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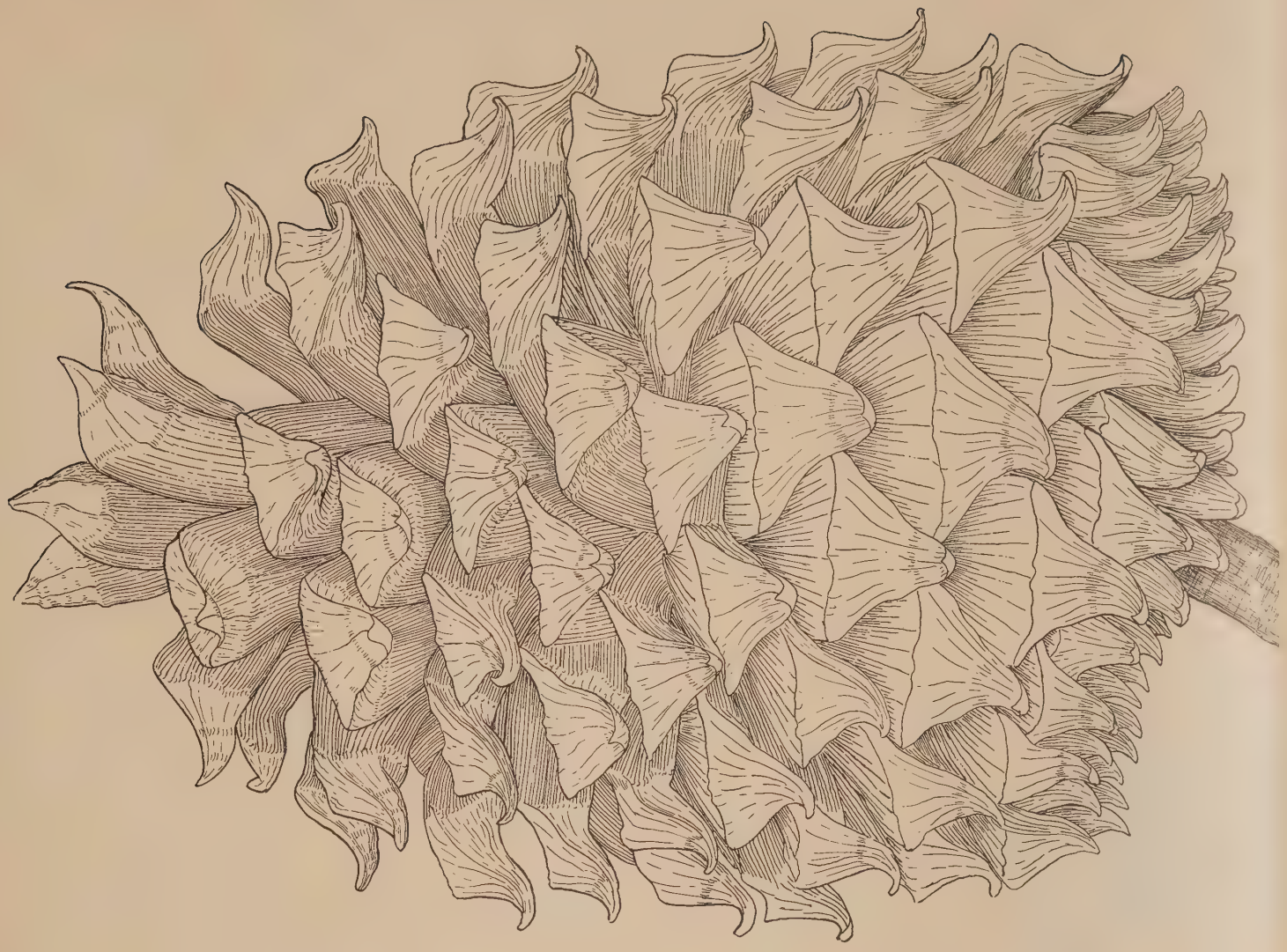
PLATE 25.

## EXPLANATION OF PLATE 25.

*Pinus Sabiniana* Dougl. (Digger Pine). Figure 1, cone (material from St. Helena); fig. 2, seed; fig. 3, circle of three peduncles, the basal scales persistent when the cones break through near the base and fall (material from Gwin Mine); fig. 4, one-year-old cone (material from Mt. Diablo, T. H. Goodspeed). Pages 86-87.

*Pinus Coulteri* Don (Big-cone Pine). Figure 5, one-year-old cone (material from Mt. Diablo). Page 84.

Figure 1 drawn by A. A. Lawson, fig. 2 by Louise Nash, fig. 3 by Mary H. Swift, figs. 4 and 5 by A. J. Heindl.



*Pinus Sabiniana* Dougl.

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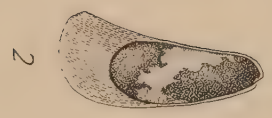

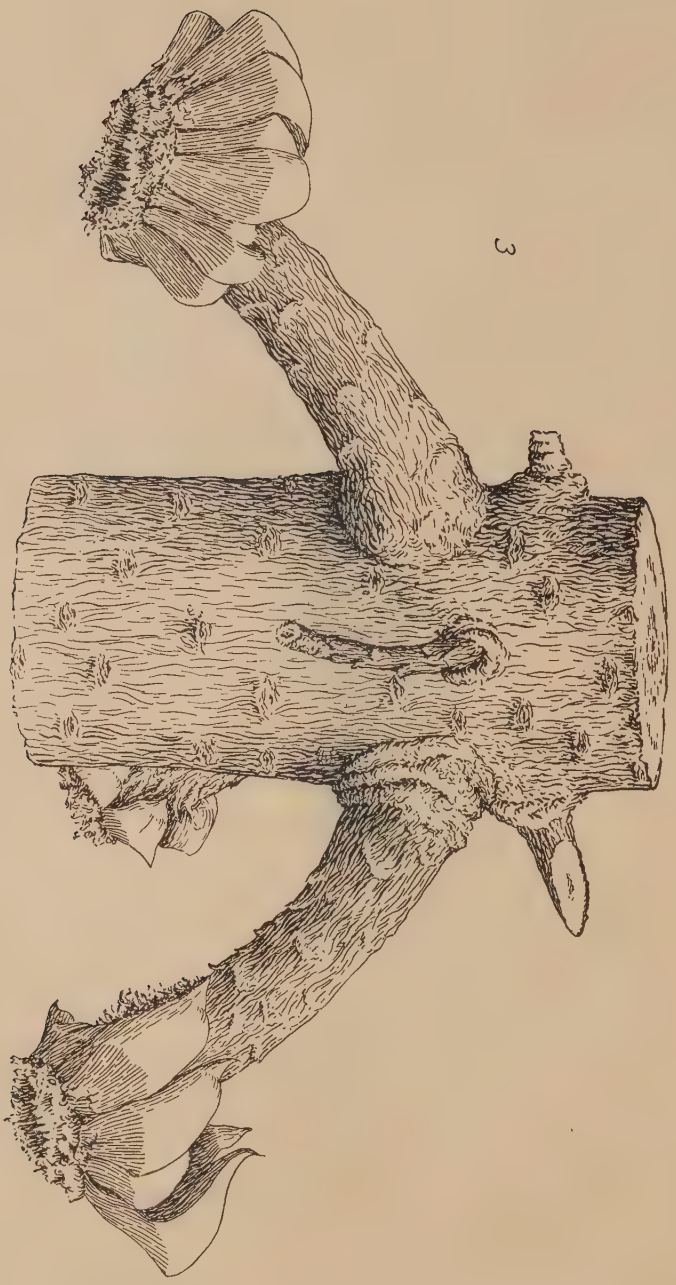

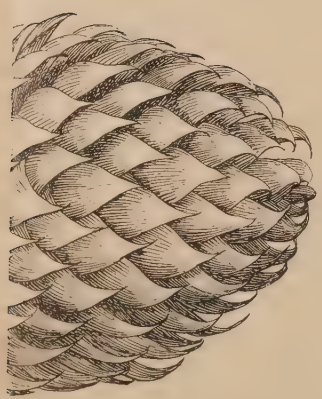

PLATE 26.

## EXPLANATION OF PLATE 26.

*Pinus Sabiniana* Dougl. (Digger Pine). "Broom type" of tree, the short trunk parting into seven erect main branches; 60 feet high and 2 feet trunk diameter. (West slope Mayacamas Range, between Blue Lakes and Ukiah.) Pages 86, 88.

Photograph by L. E. Hunt.

Broom-form of *Pinus Sabiniana* Dougl.

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PLATE 27.

## EXPLANATION OF PLATE 27.

DESERT TYPES OF CALIFORNIA PINES:

*Pinus Torreyana* Parry (Torrey Pine). Figure 1, cone; fig. 3, seed. (Material from Del Mar.) Page 91.

*Pinus monophylla* Torr. (One-leaf Piñon). Figure 2, cone; fig. 4, seed. (Material from trees on the Cottonwood Trail from Lone Pine to Volcano Creek.) Page 93.

All figures natural size. Figures 1 and 2 drawn by Mary H. Swift.

Desert pines: *Pinus Torreyana* Parry and *Pinus monophylla* Torr.

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PLATE 28.

## EXPLANATION OF PLATE 28.

FIRE TYPES OF CALIFORNIA PINES:

*Pinus muricata* Don (Bishop Pine). Figure 1, closed cone; fig. 2, seed. (Material from Inverness.) Page 95.

*Pinus tuberculata* Gord. (Knob-cone Pine). Figure 3, closed cone; fig. 4, seed. (Material from Mt. St. Helena.) Page 102.

These species represent the "fire type" of pine cones, *i.e.*, cones which remain closed and persist on the tree for an indefinite period, often for fifteen or twenty years, preserving their seed in a germinable condition until opened by a forest fire. Pages 102, 104.

All figures natural size. Figures 1 and 3 drawn by Mary H. Swift.

Closed-cone pines: *Pinus muricata* Don and *Pinus tuberculata* Gord.

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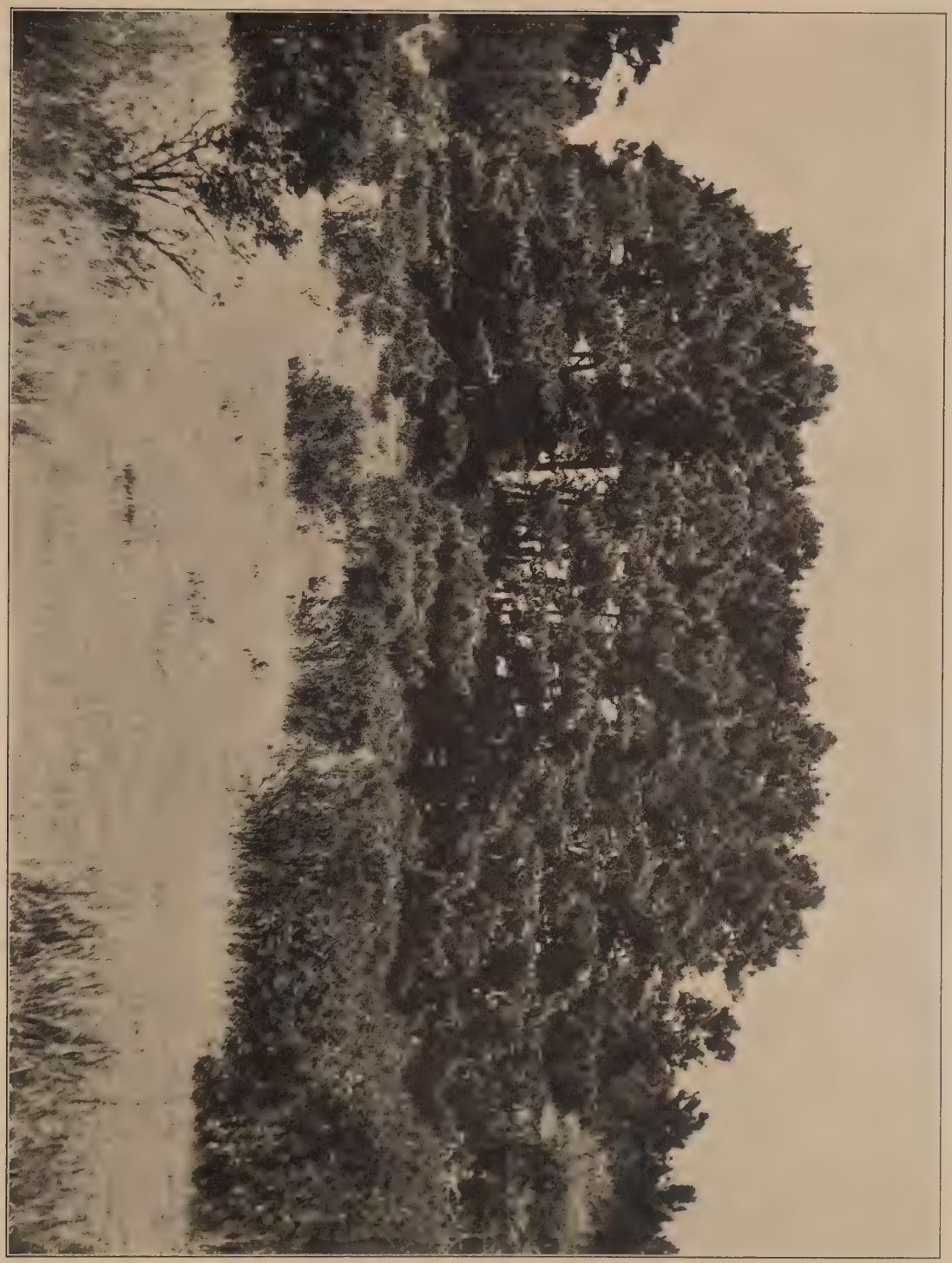
PLATE 29.

## EXPLANATION OF PLATE 29.

*Pinus muricata* Don (Bishop Pine). Typical small grove, pure mature stand, trees 50 to 65 feet high and trunk diameter 1 to 2⅔ feet. *Baccharis Douglassii* DC. (Coyote Scrub) in foreground. (Inverness, Point Reyes Peninsula, altitude 60 feet.) Pages 95, 98.

Photograph by W. L. Jepson and B. F. White.



*Pinus muricata* Don.

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PLATE 30.

## EXPLANATION OF PLATE 30.

*Pinus radiata* Don (Monterey Pine). Figure 1, typical medium-sized open cone; fig. 2, small-sized closed cone; fig. 3, seed. (Material from Monterey.) Page 100.

All figures natural size. Figure 1 drawn by Mary H. Swift, fig. 2 by A. J. Heindl.

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*Pinus radiata* Don.

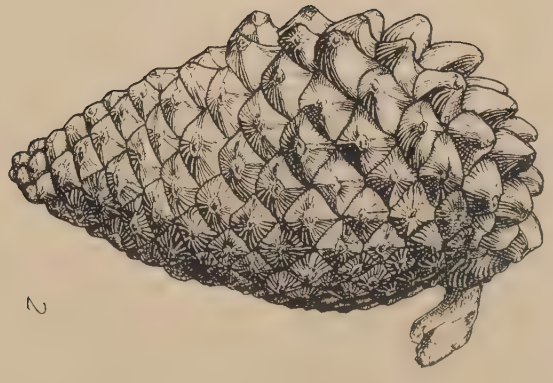

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PLATE 31.

## EXPLANATION OF PLATE 31.

*Tsuga heterophylla* Sarg. (Coast Hemlock). Figure 1, fruiting branchlet; fig. 4, open cone; fig. 2, bract and scale; fig. 3, seed. (Material from Washington and from Mendocino County.) Page 105. See also plate 43.

*Tsuga Mertensiana* Bong. (Mountain Hemlock). Figure 5, fruiting branchlet; fig. 6, bracts and scale; fig. 7, seed. (Material from West Vidette, Bubbs Creek.) Page 107.

All figures natural size. Figures 1 and 5 drawn by Mary H. Swift, the remaining figures by A. J. Heindl.

*Tsuga heterophylla* Sarg. and *Tsuga Mertensiana* Bong.

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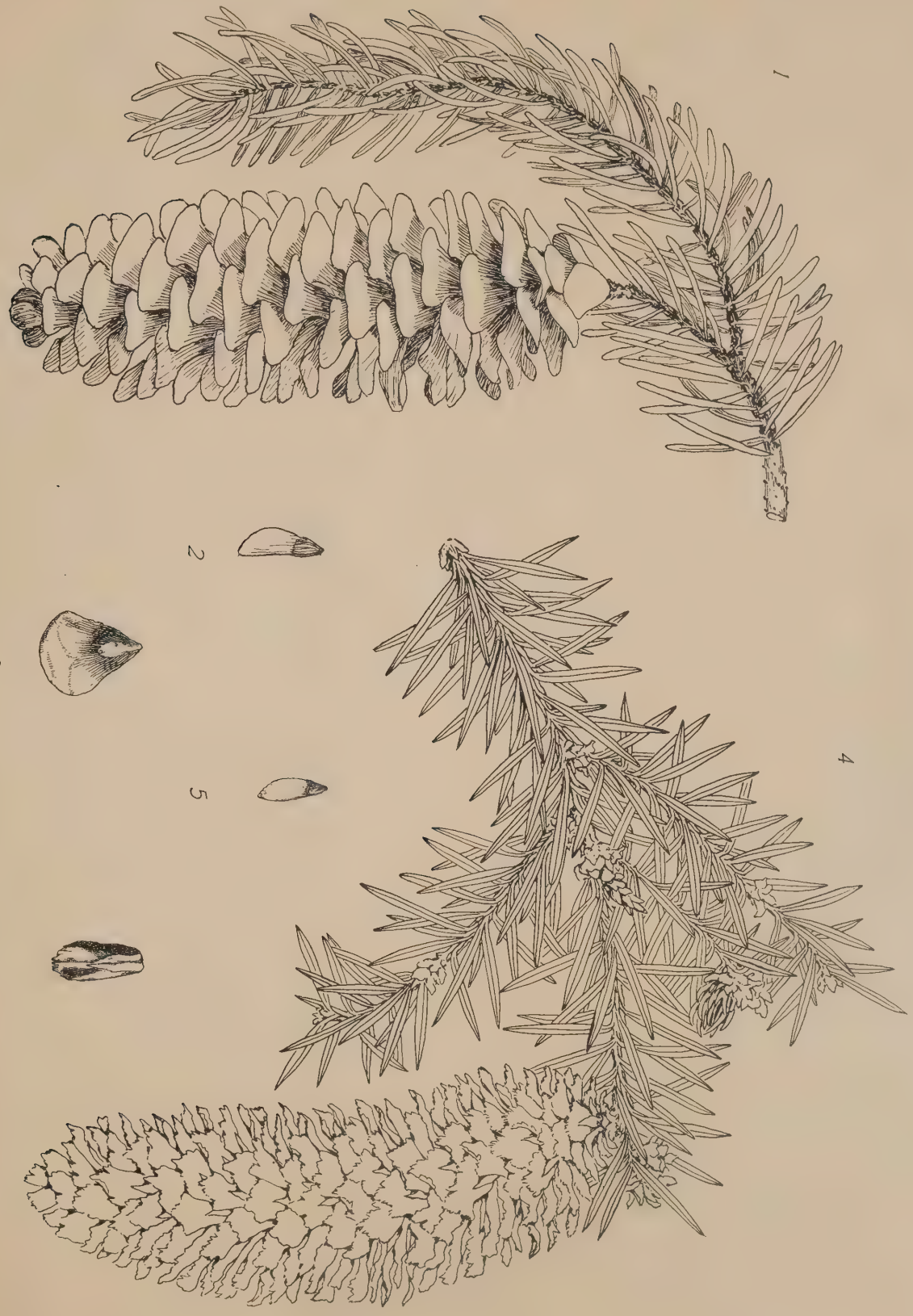
PLATE 32.

## EXPLANATION OF PLATE 32.

*Picea Breweriana* Wats. (Weeping Spruce). Figure 1, fruiting branchlet; fig. 2, seed; fig. 3, bract and scale. (Material from western Siskiyou.) Page 111.

*Picea sitchensis* Carr. (Tideland Spruce). Figure 4, fruiting branchlet (material from Humboldt County); fig. 5, seed (material from Sitka, Alaska); fig. 6, bract and scale. Page 109.

All figures natural size. Figures 1 and 2 drawn by Eloise Roorbach, figs. 3, 5, and 6 by A. J. Heindl, fig. 4 by Mary H. Swift.




*Picea Breweriana* Wats. and *Picea Sitchensis* Carr.

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PLATE 33.

## EXPLANATION OF PLATE 33.

*Pseudotsuga taxifolia* Britt. (Douglas Fir). Figure 1, cone-bearing branchlet; fig. 2, seed; fig. 3, bract and scale. (Material from Spring Mountain, Mt. Hood Range.) Page 113.

*Taxus brevifolia* Nutt. (Western Yew). Figure 4, fruiting branchlet; fig. 5, longitudinal diagram of fruit. (Material from Sherwood, Mendocino County.) Page 165.

All figures natural size. Figures 1 and 3 drawn by Eloise Roorbach, figs. 2 and 5 by A. J. Heindl, fig. 4 by Mary H. Swift.

*Pseudotsuga taxifolia* Britt., and *Taxus brevifolia* Nutt.

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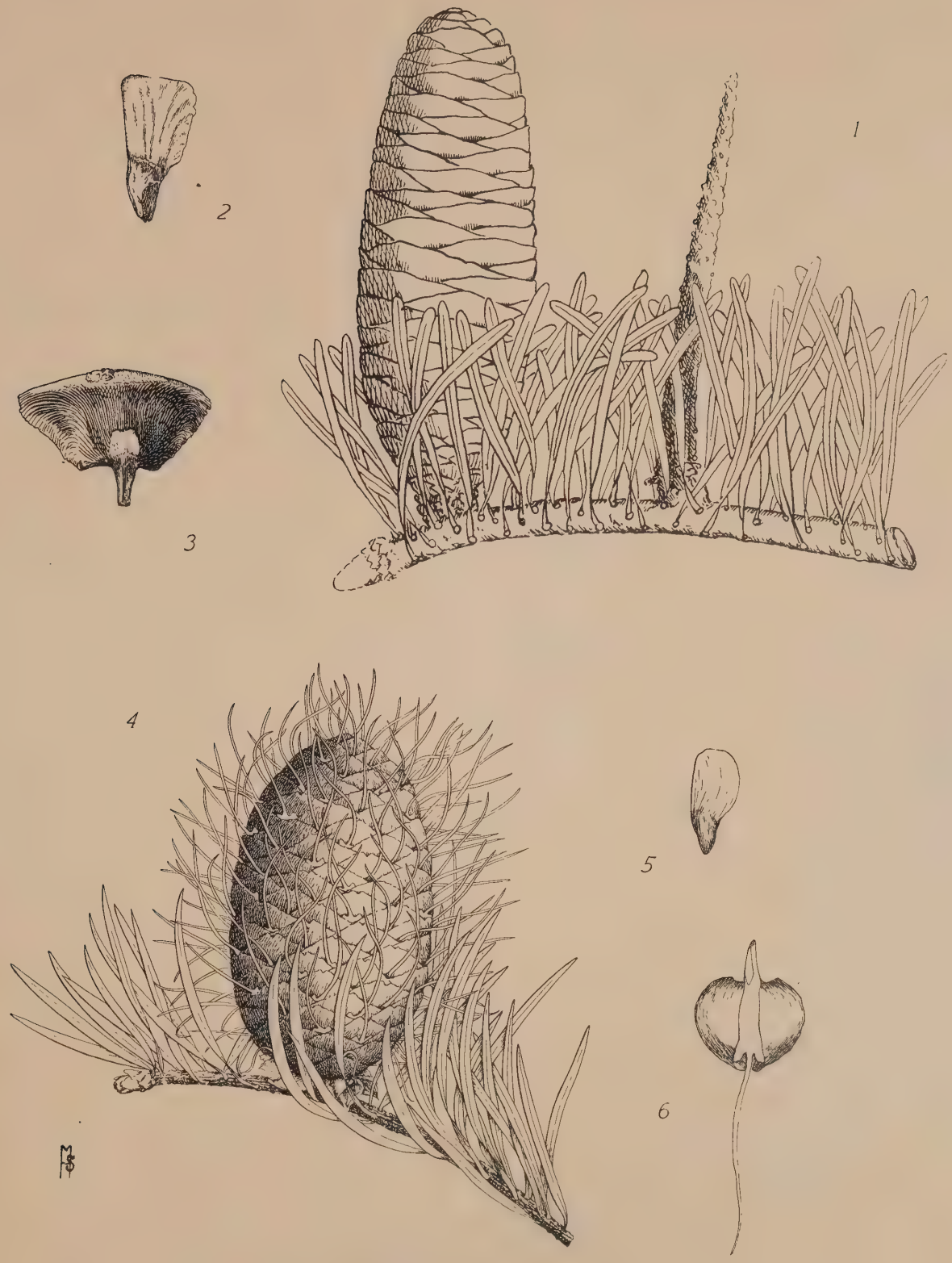
PLATE 34.

## EXPLANATION OF PLATE 34.

*Abies concolor* Lindl. & Gord. (White Fir). Figure 1, fruiting branchlet showing cone and persistent axis of another cone from which scales and seeds have fallen (material from Sierra Nevada, *W. R. Dudley*); fig. 2, seed; fig. 3, bract and scale. (Material of figs. 2 and 3 from Independence Lake). Page 119.

*Abies venusta* Koch (Santa Lucia Fir). Fig. 4, fruiting branchlet showing long bristles of the bracts; fig. 5, seed; fig. 6, bract and scale. (Material from Twin Peaks, Santa Lucia Mountains.) Page 124.

All figures natural size. Figures 1, 5, and 6 drawn by Eloise Roorbach, fig. 4 by Mary H. Swift, figs. 2 and 3 by A. J. Heindl.




*Abies concolor* Lindl. & Gord., and *Abies venusta* Koch.

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PLATE 35.

## EXPLANATION OF PLATE 35.

*Abies magnifica* Murr. (Red Fir). Figure 1, fruiting branchlet, showing exserted reflexed bracts and characteristically upturned leaves; fig. 2, seed; fig. 3, bract and scale; fig. 4, anterior view of bract and scale. (Material from Mt. Shasta.) Page 122.

All figures natural size. Drawn by Mary H. Swift.

*Abies magnifica* Murr.

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PLATE 36.

## EXPLANATION OF PLATE 36.

*Sequoia sempervirens* Endl. (Redwood). Figure 1, ordinary cone-bearing branchlet, foliage typical of lower and often of upper part of tree (material from San Leandro Cañon near Moraga Ridge); fig. 2, cone-bearing branchlet with foliage as it occurs in uppermost part of some mature trees (material from Willits); fig. 3, seed. Page 128.

Figures 1 and 2 natural size; fig. 3, × 1½. Figure 1 drawn by Eloise Roorbach, fig. 2 by Mary H. Swift, fig. 3 by A. J. Heindl.

*Sequoia sempervirens* Endl.

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PLATE 37.

## EXPLANATION OF PLATE 37.

*Sequoia sempervirens* Endl. (Redwood). Pure stand covering the mountains on both sides of the lower Eel River, descending the slopes to the river banks and even occupying an island flat in the river bed. Pages 17, 129.

Photograph by A. W. Ericson.

*Sequoia sempervirens* Endl.

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PLATE 38.

## EXPLANATION OF PLATE 38.

*Sequoia sempervirens* Endl. (Redwood). In the Santa Lucia Mountains, southern limit of its range. On account of long summer drought and low winter precipitation, the trees are sheltered in sharp, deep, straight cañons, only the tops of the Redwoods rising out of the cañons above the general level of the slope. *Platanus racemosa* Nutt (Sycamore) grows with Redwood in the lower cañon bottoms. Sides of the cañons, especially above, filled in with *Quercus agrifolia* Neé (Live Oak). Page 130.

Photograph by W. L. Jepson and B. F. White.

Sharp deep cañons of the Santa Lucia Mountains with *Sequoia sempervirens* Endl. and *Quercus agrifolia* Neé.

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PLATE 39.

## EXPLANATION OF PLATE 39.

*Sequoia sempervirens* Endl. (Redwood). Virgin stand on Bull Creek, main Eel River, Humboldt County, mainly without admixture of other species, scaling 100,000 to 500,000 feet BM. to the acre. Seasonal precipitation about 46 inches. Monthly temperatures, absolute maximums, about 70°-84°; absolute minimums, about 20°-33°. Page 131.

Photograph by A. W. Ericson.

Dense stand of *Sequoia sempervirens* Endl.

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PLATE 40.

## EXPLANATION OF PLATE 40.

Redwood destruction and reproduction. Figure 1 (upper figure), logging of *Sequoia sempervirens* Endl. (Redwood), the choice logs taken and the abandoned timber left on the ground; fig. 2, logged area showing new growth from sprouts two years after logging. (Mendocino County.) Pages 31, 133.

Photographs by L. E. Hunt.

1

2

*Sequoia sempervirens* Endl., logged areas.

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PLATE 41.

## EXPLANATION OF PLATE 41.

*Sequoia sempervirens* Endl. Redwood "fire columns," 90 feet high, showing the main axis two years after a forest fire, covered with a dense clothing of new growth two feet thick, all the branches fire-killed and now projecting through the new growth like skeletons; these branches appear white by reason of the falling away of the deadened bark and exposure of the light-colored sapwood. Page 134.

Photograph by A. W. Ericson.

"Fire-columns" of *Sequoia sempervirens* Endl.

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PLATE 42.

## EXPLANATION OF PLATE 42.

*Sequoia sempervirens* Endl. "Redwood circles." Figure 1, poles developed from stump sprouts, forming a second generation or circle of trees about parent stump (Forest Grove, Santa Cruz Mountains); fig. 2, third generation or circle of trees, derived in a similar manner but arising by sprouts from the second generation stumps (Mill Valley). Pages 31, 133.

Figure 1, photograph by W. A. Setchell; fig. 2, by W. L. Jepson.

1

2

Regeneration of *Sequoia sempervirens* Endl.

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PLATE 43.

## EXPLANATION OF PLATE 43.

Logging of Redwood (*Sequoia sempervirens* Endl.). The "undercut" (showing the white sapwood) and the fissured bark with interwoven ridges. Trunk 12 feet in diameter and 90 feet to first limb. Coast Hemlock (*Tsuga heterophylla* Sarg.) trees with slender trunks and feathery branches, at right and left of Redwood tree. Dense Redwood forest in background. (Riverside, Humboldt County.) Pages 107, 136.

Photograph by A. W. Ericson.

"Falling" a tree of *Sequoia sempervirens* Endl.—the undercut.

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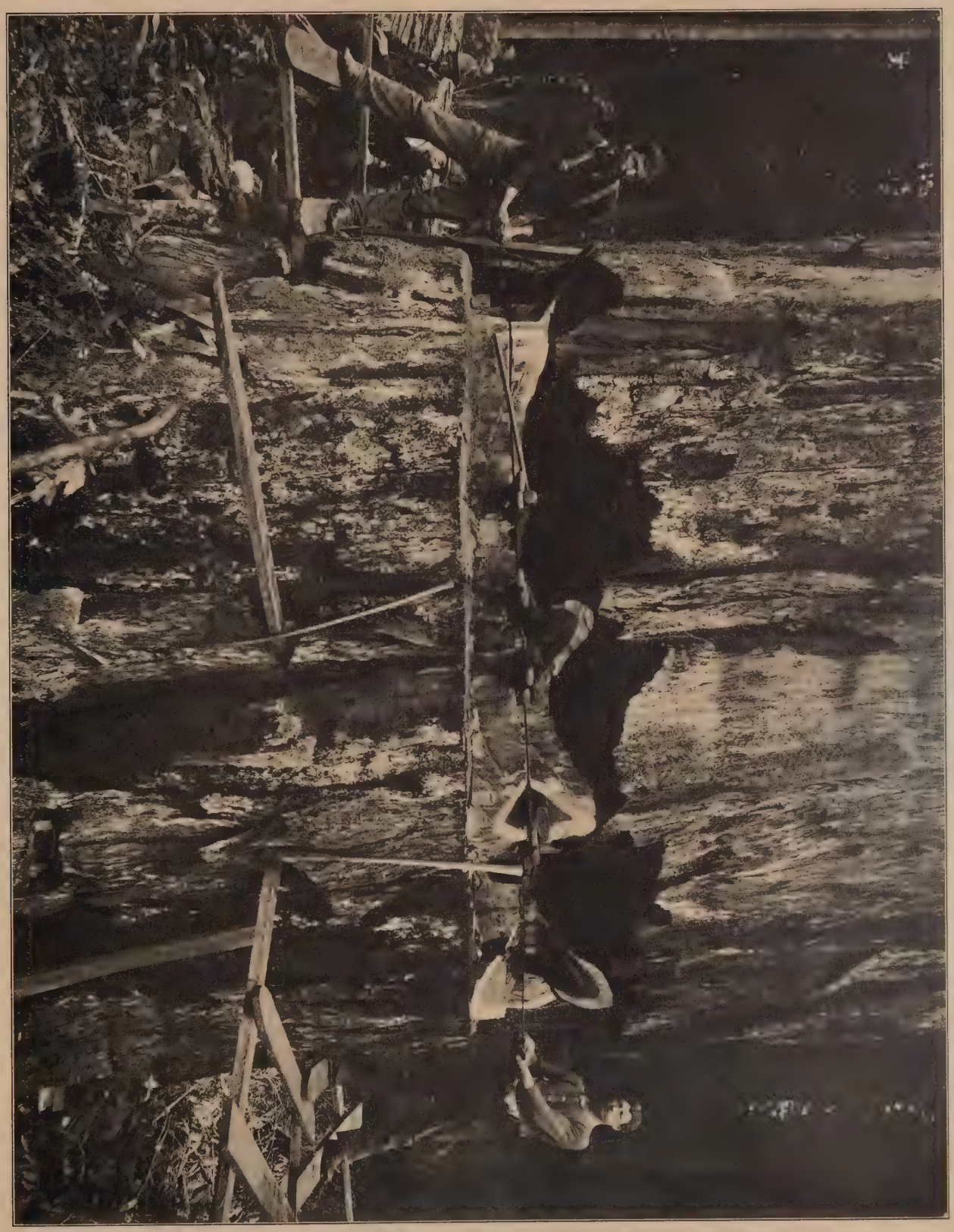
PLATE 44.

## EXPLANATION OF PLATE 44.

Logging of Redwood (*Sequoia sempervirens* Endl.). "Back cut" or "saw cut," showing the stages for the "fallers" (or workmen) to stand on, and the iron wedges driven in behind the saw to prevent biting, *i.e.*, settling down of the trunk upon the saw; tree 14 feet in diameter. (Vance's Woods, Humboldt County.) Page 136.

Photograph by A. W. Ericson.



Falling a tree of *Sequoia sempervirens* Endl.—the back cut.

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PLATE 45.

## EXPLANATION OF PLATE 45.

Logging of Redwood (*Sequoia sempervirens* Endl.). Tree 275 feet long, 150 feet to first limb. Butt log, 17 feet in diameter; log at left (partly shown), 13 feet in diameter at 16 feet from ground; log in background, 12 feet in diameter at 31 feet from ground. (Vance's Woods near Eureka.) Page 136.

Photograph by A. W. Ericson.

Logs of *Sequoia sempervirens* Endl. on the ground.

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PLATE 46.

## EXPLANATION OF PLATE 46.

Logging of Redwood (*Sequoia sempervirens* Endl.) Logs "snaked" down the slope by a donkey-engine ("logging donkey"), the wire cable taken up on a drum. Logs then made up into skid train, or "bull-load," as shown in plate 47. (Pudding Creek, Mendocino County). Page 136.

Photograph by W. T. Fitch.

"Yarding" of *Sequoia sempervirens* logs.

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PLATE 47.

## EXPLANATION OF PLATE 47.

Logging of Redwood (*Sequoia sempervirens* Endl.). Train of logs on skidway, pulled down hill by a cable attached to a larger stationary engine or "bull donkey"; 20 logs, 75,465 feet BM. (Freshwater, Humboldt County.) Page 136.

Photograph by A. W. Ericson.

Skid-train of *Sequoia sempervirens* logs.

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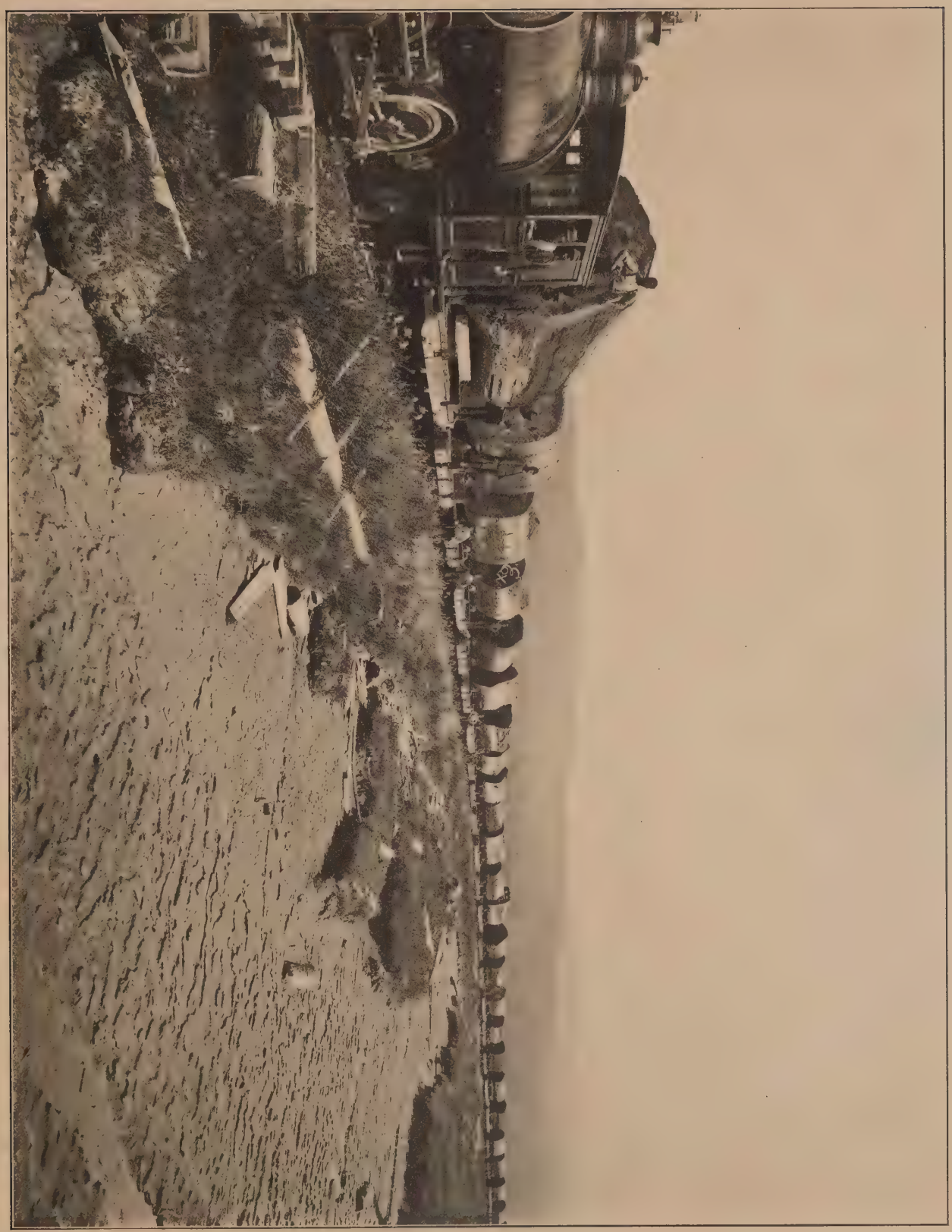
PLATE 48.

## EXPLANATION OF PLATE 48.

Logging of Redwood (*Sequoia sempervirens* Endl.). Transportation from woods to mill by logging train, 25 cars. (Freshwater, Humboldt County.) Page 136.

Photograph by A. W. Ericson.



Railway train of *Sequoia sempervirens* logs.

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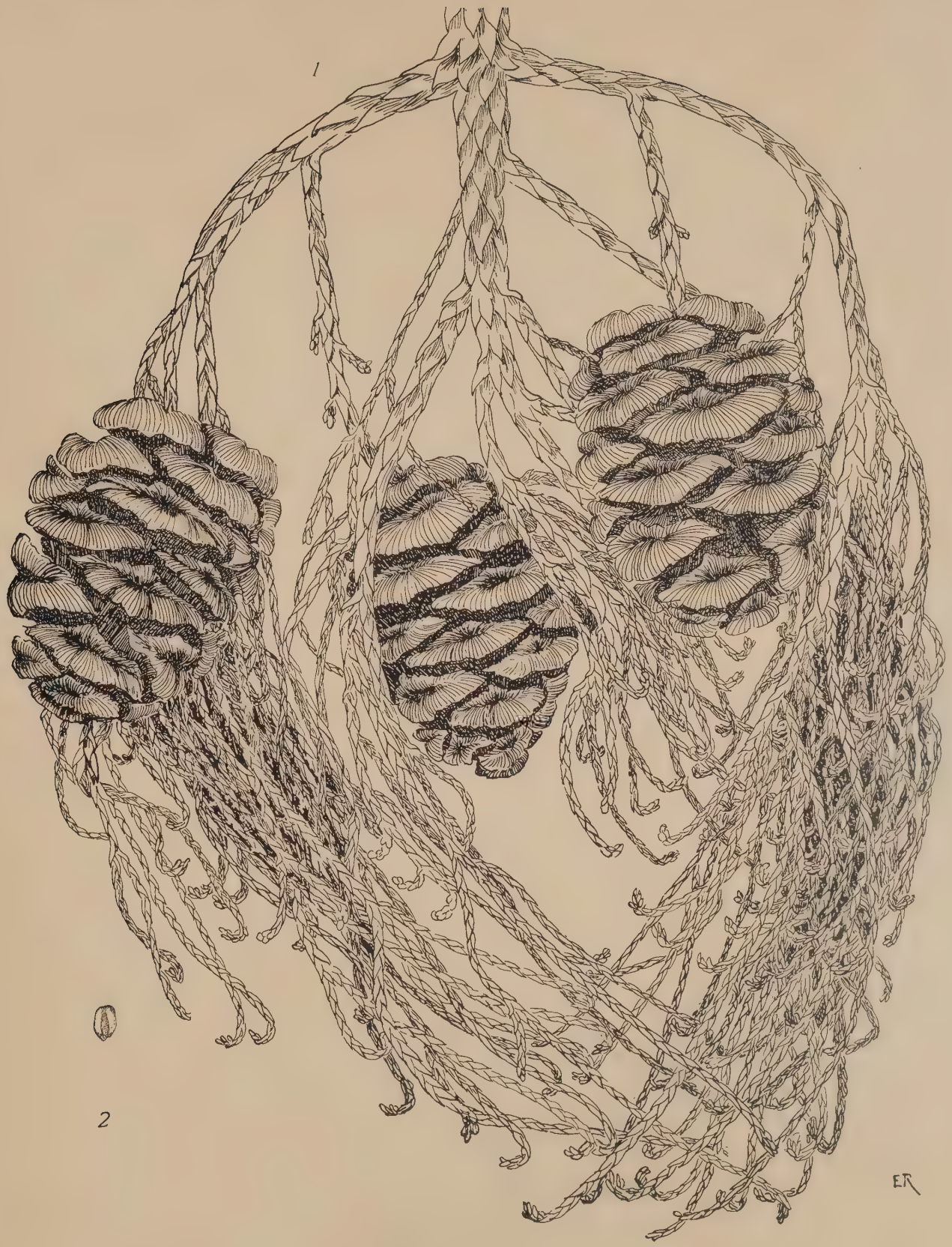
PLATE 49.

## EXPLANATION OF PLATE 49.

*Sequoia gigantea* Dec. (Big Tree). Figure 1, fruiting branch (×1); fig. 2, seed (×1½). (Material from Atwell Mill, Middle Fork Kaweah River.) Page 139.

Figure 1 drawn by Eloise Roorbach, fig. 2 by A. J. Heindl.




*Sequoia gigantea* Dec.

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PLATE 50.

## EXPLANATION OF PLATE 50.

*Sequoia gigantea* Dec. (Big Tree). Figure 1, type of tree with heavily enlarged trunk; fig. 2, tree with dead tip to the main axis, the summit typical of trees past maturity. (Atwell Mill, Middle Fork Kaweah River.) Pages 144, 145.

Photographs by W. L. Jepson.

1

2

*Sequoia gigantea* Dec., base and top.

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PLATE 51.

## EXPLANATION OF PLATE 51.

*Thuja plicata* Don (Canoe Cedar). Figure 1, fruiting branchlet with opened cones (×1); fig. 2, seed (×1½). (Material from Humboldt County and Washington.) Page 150.

*Libocedrus decurrens* Torr. (Incense Cedar). Figure 3, fruiting branchlet (×1); fig. 4, seed (×1); fig. 5, branchlet (×3). (Material from Hetch-Hetchy and Millwood.) Page 149.

Figure 1 drawn by Mary H. Swift, figs. 2, 3, and 4 by A. J. Heindl.

*Thuja plicata* Don and *Libocedrus decurrens* Torr.

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PLATE 52.

## EXPLANATION OF PLATE 52.

*Cupressus macrocarpa* Hartw. (Monterey Cypress). Figure 1, fruiting branchlet. Page 155.

*Cupressus Goveniana* Gord. (Gowen Cypress). Figure 2, cone; fig. 3, branchlet. (Material from Monterey.) Page 153.

*Cupressus Sargentii* Jepson (Sargent Cypress). Figure 6, cone. (Material from Red Mountain.) Page 158.

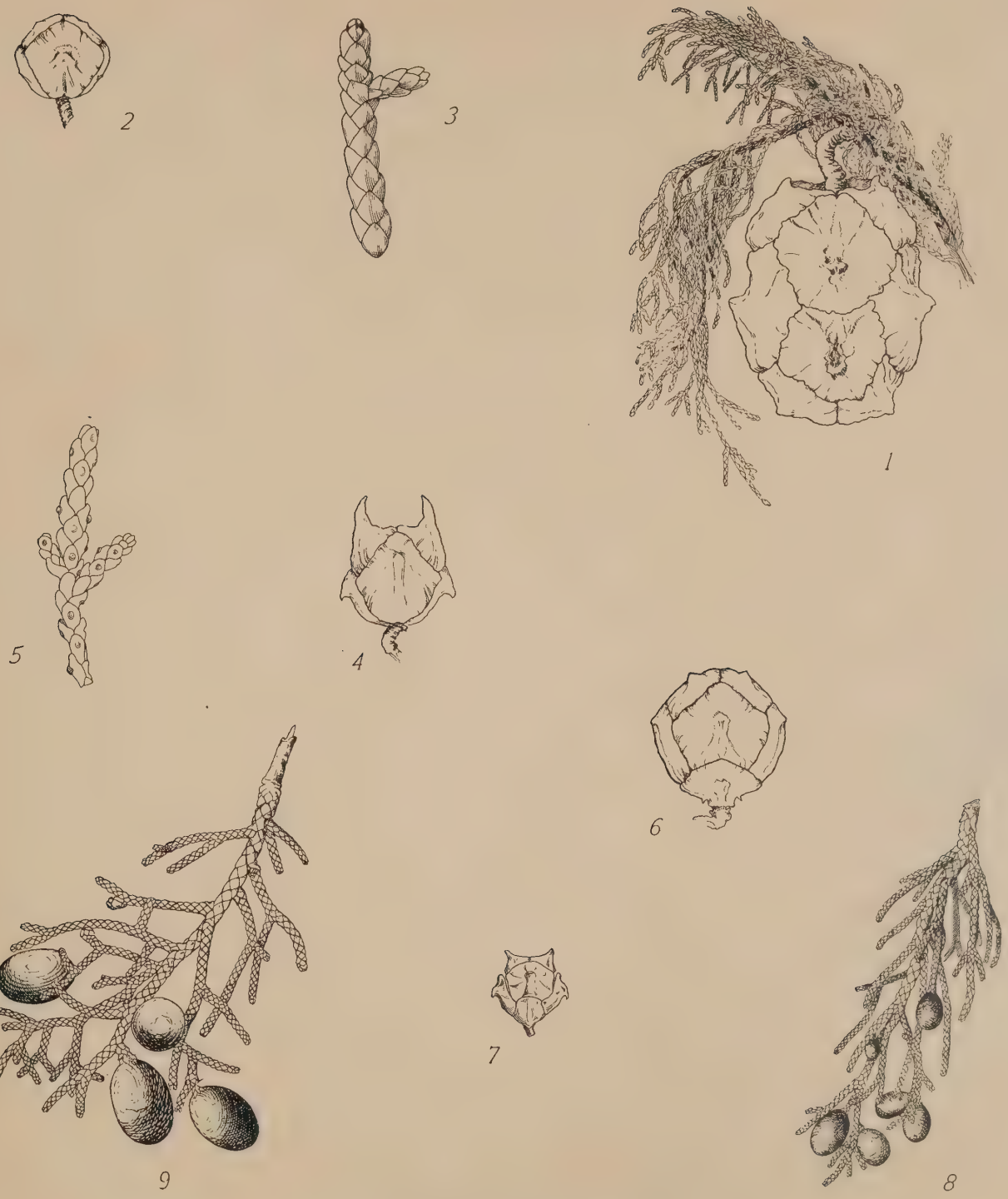
*Cupressus Macnabiana* Murr. (Macnab Cypress). Figure 4, cone; fig. 5, branchlets showing resin glands on back of leaves. (Material from near Samuels Springs, Napa County.) Page 159.

*Cupressus Bakeri* Jepson (Modoc Cypress). Figure 7, cone. (Material from southeastern Siskiyou County.) Page 160.

*Juniperus occidentalis* Engelm. (Sierra Juniper). Figure 8, fruiting branchlet. (Material from near Mt. Whitney.) Page 163.

*Juniperus californica* Carr. (California Juniper). Figure 9, fruiting branchlet. (Material from the San Carlos Range.) Page 162.

Figures 5 and 6, $\times 2$, all others natural size. Figs. 1, 2, 4, 6, and 7 drawn by Eloise Roorbach, figs. 3, 5, 8, and 9 by A. J. Heindl.




Types of California Cypresses and Junipers.

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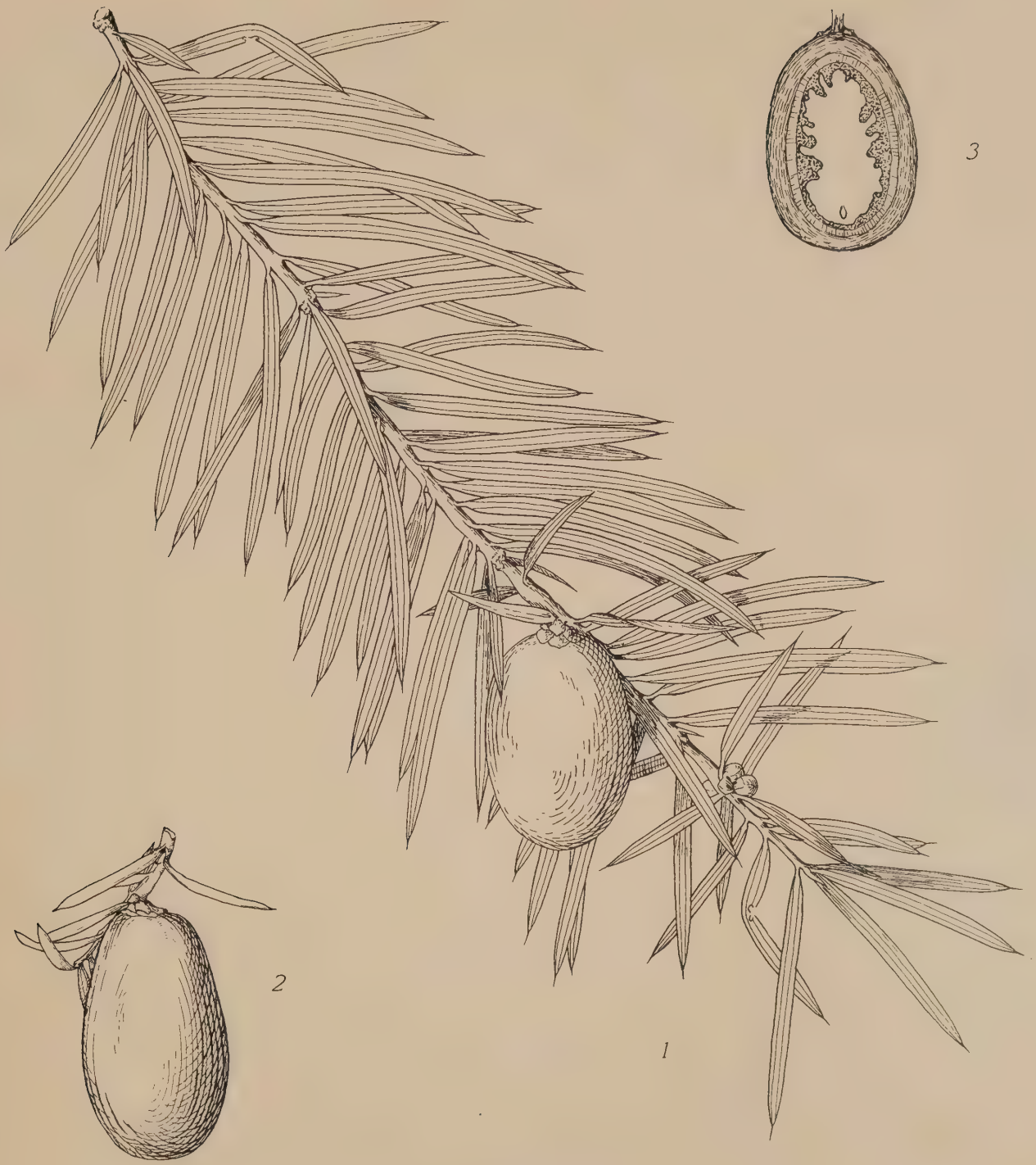
PLATE 53.

## EXPLANATION OF PLATE 53.

*Torreya californica* Torr. (California Nutmeg). Figure 1, fruiting branchlet with typical fruit (material from Redwood Cañon, Middle Fork Kaweah River); fig. 2, pear-shaped type of fruit (material from Mt. Tamalpais); fig. 3, longitudinal section of fruit, showing laminated endosperm and minute embryo at upper end. Page 167.

All figures natural size. Figure 1 drawn by Mary H. Swift, fig. 2 by A. J. Heindl, fig. 3 by Eloise Roorbach.




*Torreya californica* Torr.

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PLATE 54.

## EXPLANATION OF PLATE 54.

*Yucca brevifolia* Engelm. (Tree Yucca). Typical desert landscape in the Mohave Desert, showing the scattered growth of Yuccas and the characteristic sage-brush. (Tree three miles west of Lancaster.) Page 170.

Photograph by C. C. Pierce.

(Copyrighted by C. C. Pierce & Co., Los Angeles, Cal., 1903.)

*Yucca brevifolia* Engelm.

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PLATE 55.

## EXPLANATION OF PLATE 55.

*Washingtonia filifera* Wendl. (Washington Palm). Grove on hillside in Chuckawalla Cañon, eight miles northerly from Indio. Stems of younger trees clothed to the ground with persistent leaves; persistent stumps of dead trees visible in the middle of the plate. Pages 20, 172.

Photograph by C. C. Pierce.

*Washingtonia filifera* Wendl.

(Copyrighted by C. C. Pierce & Co., Los Angeles, Cal., 1903.)

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PLATE 56.

## EXPLANATION OF PLATE 56.

*Salix lasiandra* Benth. (Yellow Willow). Figure 1, pistillate catkin; fig. 2, staminate catkin; fig. 3, mature leaf. (Material from Berkeley.) Page 175.

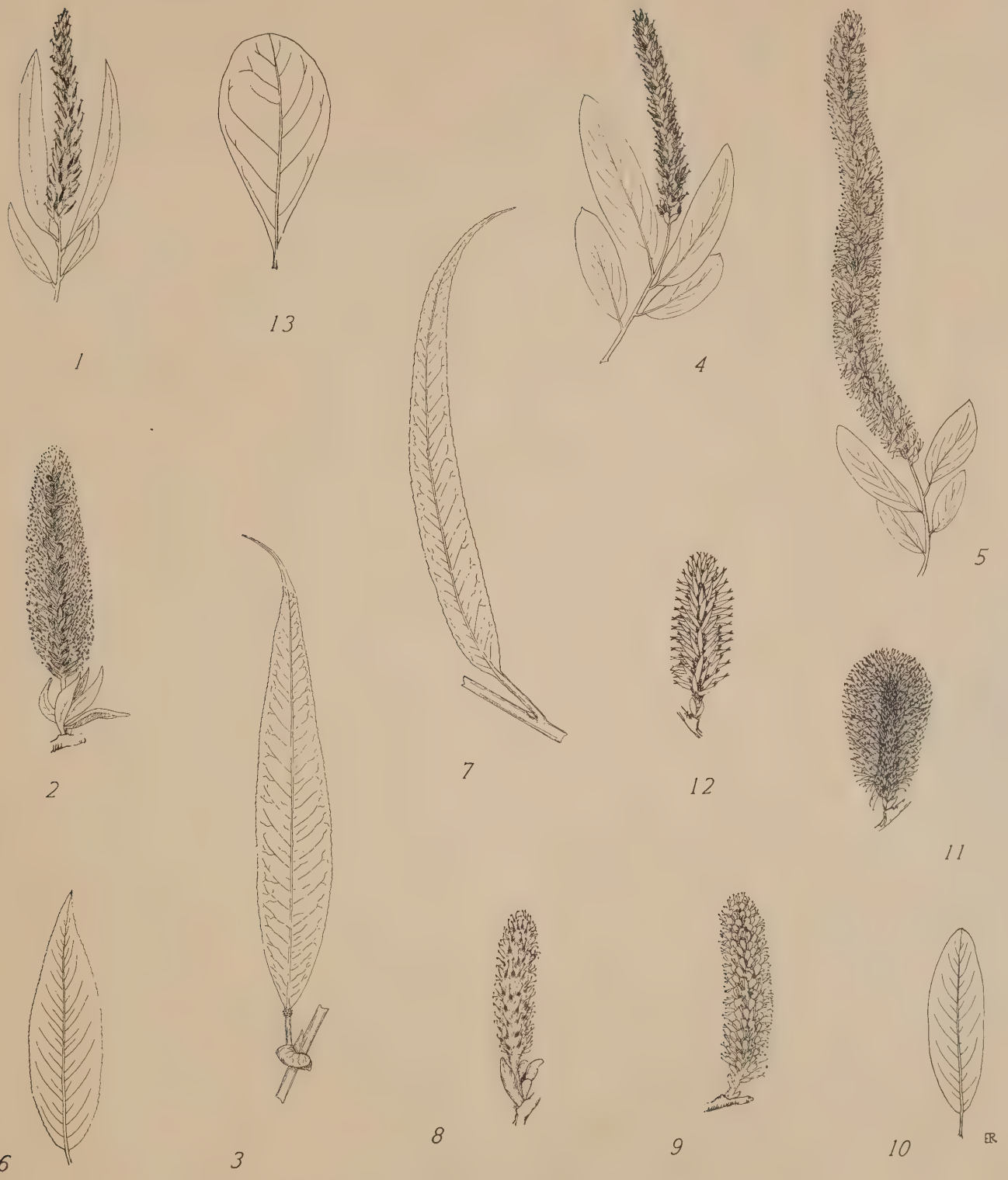
*Salix laevigata* Bebb (Red Willow). Figure 4, pistillate catkin; fig. 5, staminate catkin; fig. 6, mature leaf. (Material from Berkeley.) Page 176.

*Salix nigra* Marsh (Black Willow). Figure 7, mature leaf. (Material from Tyler Island, lower Sacramento River.) Page 177.

*Salix lasiolepis* Benth. (Arroyo Willow). Figure 8, pistillate catkin; fig. 9, staminate catkin; fig. 10, mature leaf. (Material from Berkeley.) Page 179.

*Salix flavescens* Nutt. (Nuttall Willow). Figure 11, pistillate catkin; fig. 12, staminate catkin (material for figures 11 and 12 from Giant Forest); fig. 13, mature leaf (material from Russian River near Guerneville). Page 180.

Figures 3, 6, 7, 10, and 13, one-half natural size; all others natural size. Figures 3 and 7 drawn by A. W. Lawson, the remainder by Eloise Roorbach.




California *Salix* species,—arborescent types.

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PLATE 57.

## EXPLANATION OF PLATE 57.

*Juglans californica* Wats. (California Walnut). Figure 1, fruiting branch, taken in late autumn, showing the clustered nuts; leaflets mostly falling separately, that is, in advance of the petiole—but this phenomenon less pronounced here than in the Buckeye ($\times \frac{1}{2}$); fig. 2, nut (natural size); fig. 3, cross-section of nut (natural size). Page 192.

Material of figure 1 from Covina; of fig. 2 from Nordhoff. Figure 1 drawn by Mary H. Swift, fig. 2 by A. J. Heindl, fig. 3 by Eloise Roorbach.

*Juglans californica* Wats.

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PLATE 58.

## EXPLANATION OF PLATE 58.

*Alnus rubra* Bong. (Red Alder). Figure 1, flowering branchlet with pendulous staminate catkins and ascending pistillate catkins; fig. 2, woody cones with opened scales; fig. 3, nutlet; fig. 4, leaf (× ½); fig. 6, cone in detail (× 1). (Material from Berkeley.) Page 199.

*Alnus rhombifolia* Nutt. (White Alder). Figure 5, leaf (× ½). (Material from Mt. Diablo.) Page 197.

Figure 1 drawn by Mary H. Swift, fig. 2 by Eloise Roorbach, figs. 3, 4, and 5 by A. J. Heindl, fig. 6 by Louise Nash.

California *Alnus* species,—arborescent types.

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PLATE 59.

## EXPLANATION OF PLATE 59.

*Alnus rubra* Bong. (Red Alder). Characteristic alder swamp on coast; trees 9 inches to 2 feet in diameter and 50 to 75 feet high. (Redwood Cañon, south of Mt. Tamalpais, Marin County). Page 199.

Photograph by Gustav Eisen and G. A. Mitchell.

Grove of *Alnus rubra* Bong.

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PLATE 60.

## EXPLANATION OF PLATE 60.

*Quercus lobata* Neé (Valley Oak). Figure 1, leaf; fig. 2, leaf; figs. 3, 4, acorn. Page 204.

*Quercus Douglasii* H. & A. (Blue Oak). Figure 5, leaf (material from Ukiah, *W. L. J.*, no. 2239); fig. 6, leaf (material from Mt. Diablo); figs. 7, 8, acorn (material from Araquipa Hills, western Solano County). Page 214.

Figures 1, 2, 5, and 6 drawn by A. J. Heindl, figs. 3, 4, 7, and 8 by Mary H. Swift.

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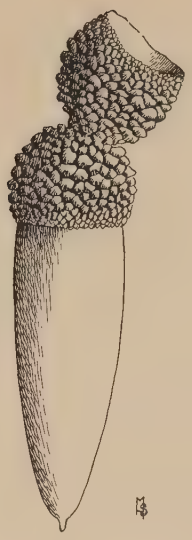

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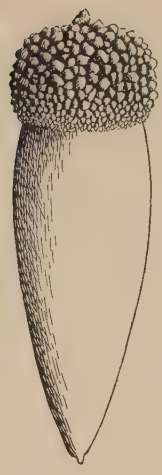

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White oaks: *Quercus lobata* Neé and *Quercus Douglasii* H. & A.

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PLATE 61.

## EXPLANATION OF PLATE 61.

*Quercus lobata* Neé (Valley Oak). Typical Coast Range clusters in Ukiah Valley; trees 70 to 115 feet high, trunks 3 to 6 feet in diameter. Average seasonal rainfall, 35 inches; maximum temperatures, drought season (May-October), 90°-111°; minimum temperatures, wet season (November-April), 21°-33°. Pages 11, 205.

Photograph by W. L. Jepson and B. F. White.

*Quercus lobata*; clump on valley floor.

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PLATE 62.

## EXPLANATION OF PLATE 62.

*Quercus lobata* Neé (Valley Oak). Characteristic bark showing the cuboid-broken fissuring, often 3 to 4 inches thick and fairly fire-resistant. (Lake County.) Pages 11, 209.

Photograph by L. E. Hunt.

*Quercus lobata;* trunk.

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PLATE 63.

## EXPLANATION OF PLATE 63.

*Quercus lobata* Neé (Valley Oak). Vase-shaped type of trees. Figure 1 shows well the dense growth of temporary lateral branches along the main trunk; 40 feet high, 1⅔ feet in diameter at 3 feet above the ground; fig. 2 (another tree) illustrates a later stage, the lateral limbs largely deciduous; 65 feet high, 1½ feet in diameter at 3 feet above the ground. (Ukiah Valley.) Page 205.

Photograph by W. L. Jepson.

1

2

Vase-shaped stage of *Quercus lobata* Née.

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PLATE 64.

## EXPLANATION OF PLATE 64.

*Quercus lobata* Neé (Valley Oak). Tall, narrow type with tall trunk and smoothish bark; height, 125 feet; trunk, 45 feet tall, 3⅔ feet in diameter at 5 feet from the ground; notice human figure at the foot of the tree. (Scott Valley, Lake County.) Page 206.

Photograph by L. E. Hunt.

*Quercus lobata* Neé.

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PLATE 65.

## EXPLANATION OF PLATE 65.

*Quercus lobata* Neé (Valley Oak). Detail of trunk of tree shown in plate 64; compare the smoothish bark with typical bark in plate 62, and see page 206.

Photograph by W. L. Jepson and B. F. White.

Trunk of *Quercus lobata* Née.

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PLATE 66.

## EXPLANATION OF PLATE 66.

*Quercus lobata* Neé (Valley Oak). Tree enshrouded and killed by the foliage drapery of *Vitis californica* Benth. (California Grape). Column 60 feet high. (Scott Valley, Lake County.) Page 209.

Photograph by L. E. Hunt.

*Quercus lobata;* tree enshrouded by *Vitis californica* Benth.

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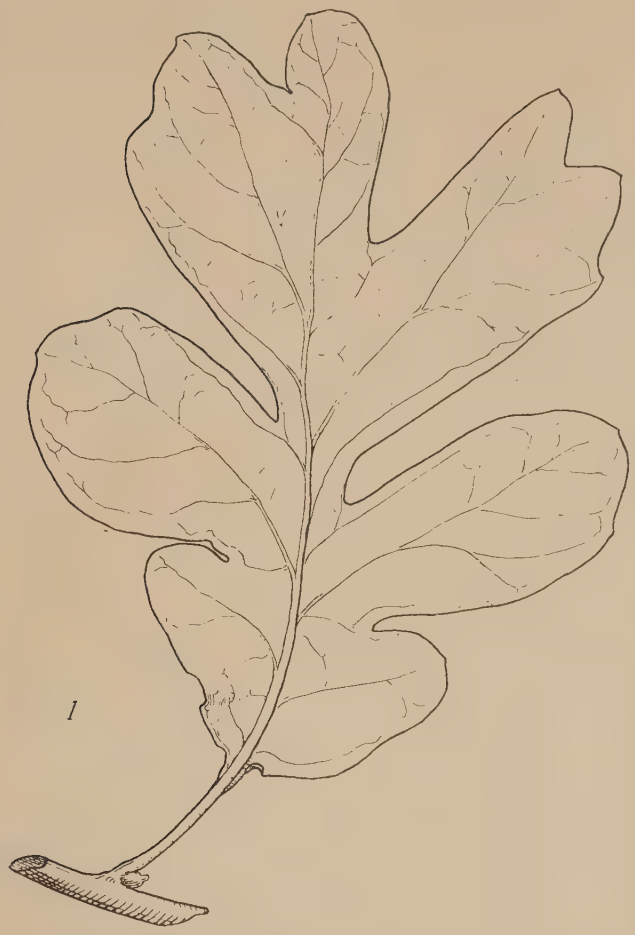
PLATE 67.

## EXPLANATION OF PLATE 67.

*Quercus Garryana* Dougl. (Oregon Oak). Figure 1, leaf, round-lobed type (*W. L. J.*, no. 1825); fig. 2, leaf, sharp-lobed type (*W. L. J.*, no. 2406); figs. 3, 4, acorns. (Material from Willits.) Pages 210, 211.

Var. *Breweri* Jepson (Brewer Oak). Figure 5, leaf. (Material from *Brewer*, no. 1336.) Page 211.

Leaves $\times \frac{1}{2}$; all other figures natural size. Figures 1, 2, and 5 drawn by A. J. Heindl, figs. 3 and 4 by Mary H. Swift.



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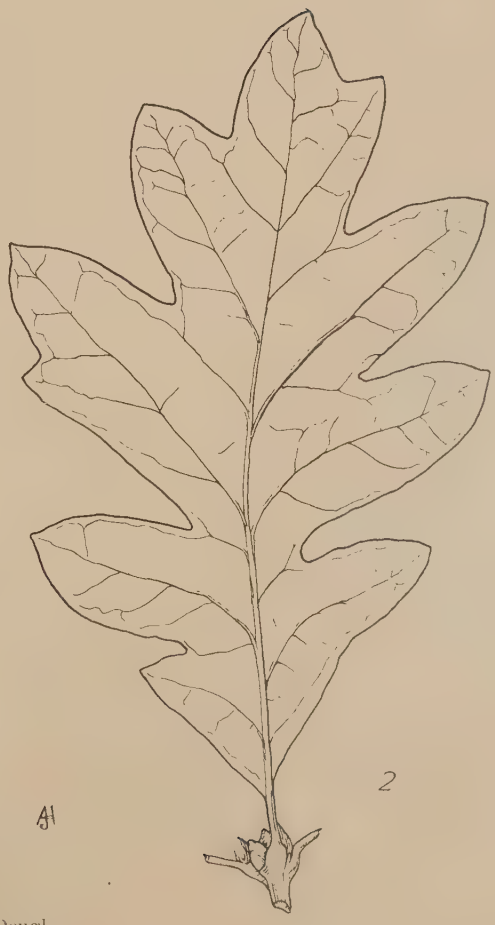

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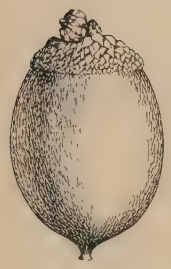

4

5

*Quercus Garryana* Dougl.

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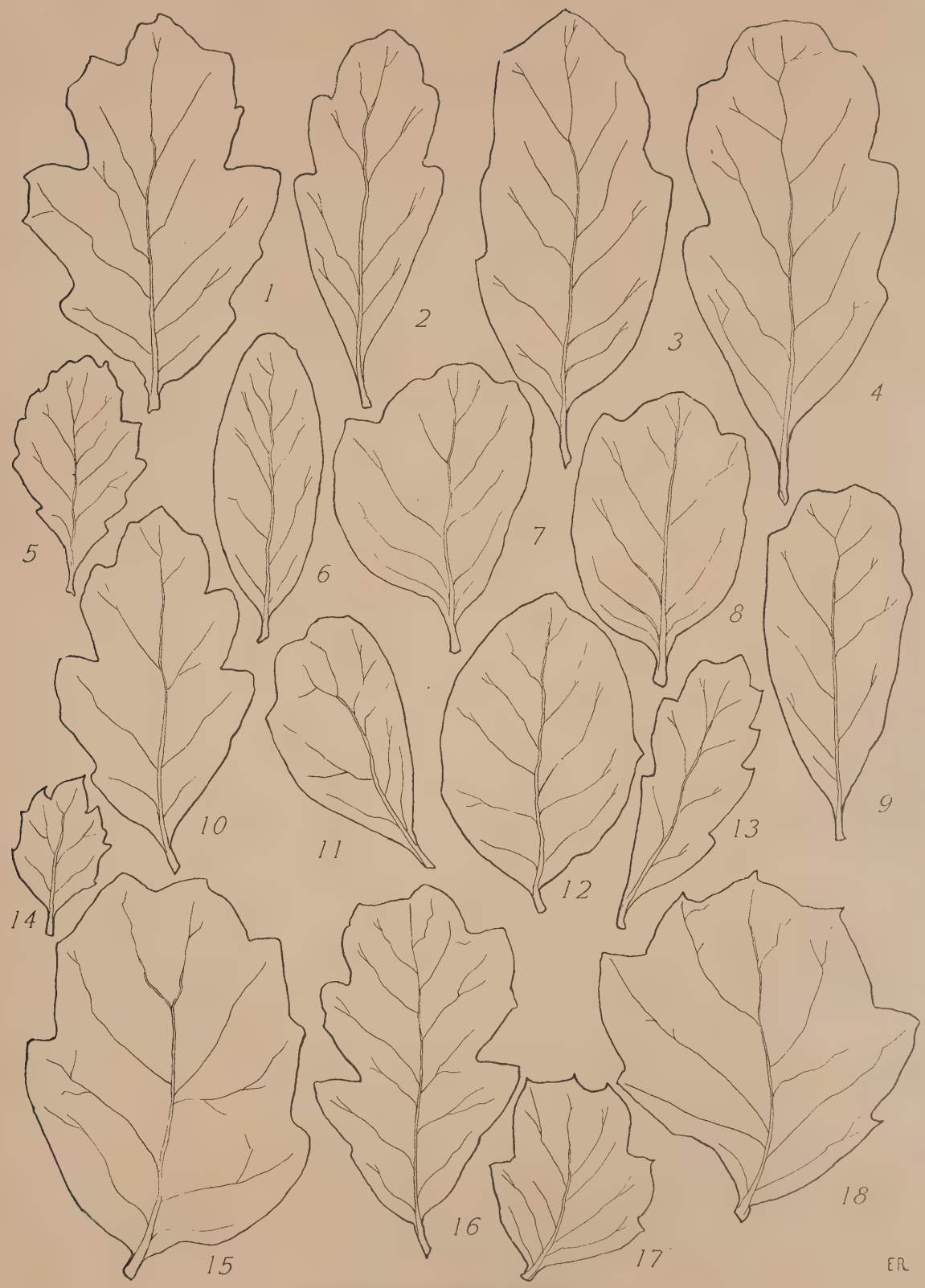
PLATE 68.

## EXPLANATION OF PLATE 68.

Leaf-variation in *Quercus Douglasii* H. & A. (Blue Oak). Figures 1-13, all from one tree, part of no. 2970, *W. L. J.*, St. Helena, the remaining figures from other trees in the same hill country. Pages 214, 215.

(× ⅕.) Drawn by Eloise Roorbach.




Leaf variation in *Quercus Douglasii* H. & A.

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PLATE 69.

## EXPLANATION OF PLATE 69.

*Quercus chrysolepis* Liebm. (Maul Oak). Figure 1, leaf; figure 2, leaf (material for figs. 1 and 2 from North Coast Ranges); fig. 3, leaf (material from Irishtown, Amador County, *Hansen*, no. 1382); fig. 4, acorn (material from Ukiah). Page 221.

Forma *grandis* Jepson. Figure 5, acorn. (Material from Ukiah.) Page 224.

Forma *Hansenii* Jepson. Figure 6, acorn. Page 224.

*Quercus vaccinifolia* Kell. (Huckleberry Oak). Figure 17, leaf; fig. 8, acorn. (Material from Sierra Nevada near Tahoe.) Page 224.

All figures natural size; drawn by A. J. Heindl.

1

2

4

3

5

6

7

8

*Quercus chrysolepis* Liebm.—Variation in leaf and acorn. *Quercus vaccinifolia* Kell.

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PLATE 70.

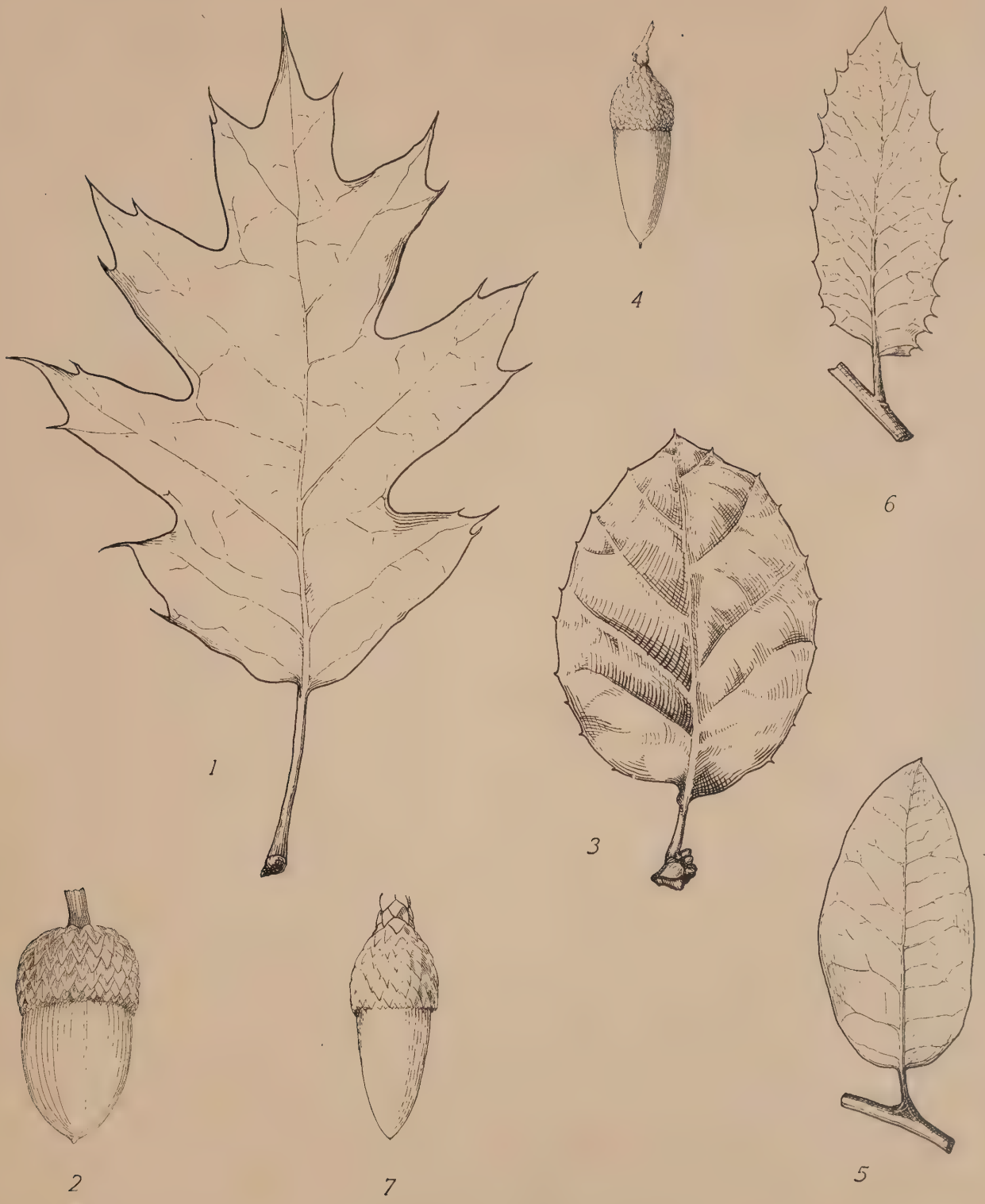
## EXPLANATION OF PLATE 70.

*Quercus Kelloggii* Newb. (Black Oak). Figure 1, typical leaf; fig. 2, acorn. (Material from St. Helena.) Page 232.

*Quercus agrifolia* Neé (Coast Live Oak). Figure 3, typical leaf; fig. 4, acorn. (Material from Berkeley.) Page 225.

*Quercus Wislizenii* DC. (Interior Live Oak). Figures 5, 6, typical leaves; fig. 7, acorn. (Material from Vacaville.) Page 229.

Leaves $\times \frac{1}{2}$; all other figures natural size. Figures 1, 3, 5, and 6 drawn by A. J. Heindl, fig. 2 by A. A. Lawson, fig. 4 by Mary H. Swift, fig. 7 by Eloise Roorbach.




Leaf and acorn types of Californian black oaks.

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PLATE 71.

## EXPLANATION OF PLATE 71.

*Quercus agrifolia* Neé (Live Oak). Typical trees of Coast Range valleys, 40 to 50 feet high with trunks 2 to 3 feet in diameter, the crowns broader than high. The trunks even on valley floors are frequently leaning, as shown in fig. 1. The wide-spreading lower limbs very often sweep the ground at their extremities as illustrated in fig. 2.

Figure 1. 40 feet high, 1⅔ feet in diameter at 3 feet above the ground.

Figure 2. 65 feet high, 1½ feet in diameter at 3 feet above the ground. Pages 13, 225.

Photographs by John C. Merriam.

1

2

*Quercus agrifolia* Neé.

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PLATE 72.

## EXPLANATION OF PLATE 72.

Leaf-variation in *Quercus Wislizenii* DC. (Interior Live Oak). Figures 1 to 13, the leaves all from one tree, part of no. 2981, *W. L. J.* (Araquipa Hills, Solano County). Figures 4, 5, 6, 8, and 9, typical spiny-leaved forms of *Quercus Wislizenii*. Figures 1, 2, 3, and 7, outline similar to leaves of *Quercus agrifolia* Neé. Figures 10, 11, 12, and 13, length and general outline, save disposition to be entire, suggestive of *Quercus Morehus* Kellogg. Page 229.

(×⅘.) Drawn by Eloise Roorbach.

Variation in leaves of *Quercus Wislizenii* A. DC.

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PLATE 73.

## EXPLANATION OF PLATE 73.

*Pasania densiflora* Oerst. (Tan Oak). Figure 1, flowering branch, some of the staminate catkins with pistillate flowers at base; figs. 2 and 3, acorn. (Material from Inverness.) Page 235.

Figure 1, × ¾; figs. 2 and 3, × 1. Drawn by Mary H. Swift.

*Pasania densiflora* Oerst.

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PLATE 74.

## EXPLANATION OF PLATE 74.

*Castanopsis chrysophylla* A. DC. (Giant Chinquapin). Typical trunk of tree 95 feet high in dense Douglas Fir and Madroña woods of Mendocino County; trunk diameter 4½ feet at 4 feet above the ground. Page 239.

Photograph by W. L. Jepson.

Trunk of *Castanopsis chrysophylla* A. DC.

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PLATE 75.

## EXPLANATION OF PLATE 75.

*Castanopsis sempervirens* Dudley (Bush Chinquapin). Characteristic low or semi-prostrate growth on granite slopes at altitudes of 7000 to 9000 feet in the California mountains. (Tauquitz Peak, San Jacinto Range, 8500 feet altitude.) Page 241.

Photograph by W. L. Jepson and B. F. White.

*Castanopsis sempervirens* Dudley.

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PLATE 76.

## EXPLANATION OF PLATE 76.

*Umbellularia californica* Nutt. (California Laurel). Tree with pendulous branchlets, in outline recalling the Valley Oak; height, 75 feet; crown diameter, 93½ feet; trunk diameter, 5 feet. (Bench of the Russian River near Cloverdale.) Pages 242, 245.

Photograph by W. L. Jepson and B. F. White.

Isolated tree of *Umbellularia californica* Nutt.

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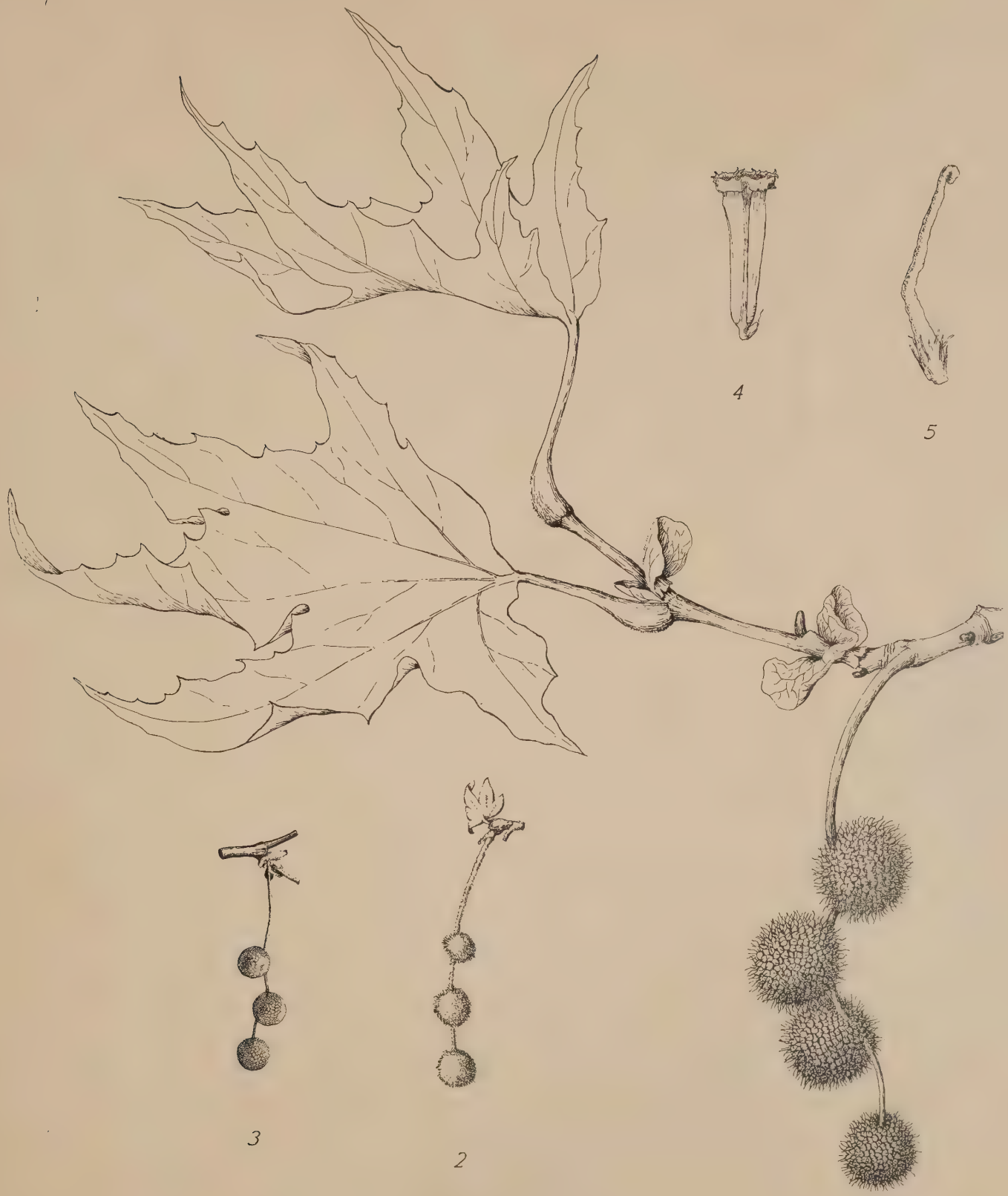
PLATE 77.

## EXPLANATION OF PLATE 77.

*Platanus racemosa* Nutt. (Western Sycamore). Figure 1, fruiting branch (material from Santa Barbara); fig. 2, pistillate inflorescence; fig. 3, staminate inflorescence; fig. 4, stamen; fig. 5, pistil. Pages 247-248.

Figure 1, × ¾; figs. 2 and 3, × 1; figs. 4 and 5, × 6. Figure 1 drawn by Mary H. Swift, the remaining figures by A. J. Heindl.




*Platanus racemosa* Nutt.

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PLATE 78.

## EXPLANATION OF PLATE 78.

*Platanus racemosa* Nutt. (Western Sycamore). Typical stream-bed growth, the trees with more or less leaning trunks. (San Martin, in the Gilroy Valley. Absolute maximum summer temperature, about 99° to 104°. Absolute minimum winter temperature, 20° to 33°. Seasonal precipitation, about 19 inches.) Page 248.

Photograph by H. P. Chandler.

*Platanus racemosa* Nutt.—typical stream-bed growth.

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PLATE 79.

## EXPLANATION OF PLATE 79.

*Aesculus californica* Nutt. (California Buckeye). Figure 1, flowering thryse (a little over one-half natural size); fig. 2, perfect (fertile) flower (×1); fig. 3, staminate (sterile) flower (×1); fig. 4, fertile pistil (a little enlarged); fig. 5, sterile pistil (a little enlarged); fig. 6, fruit (×1); fig. 7, seed (×1); fig. 18, bursting winter bud (×½). (Material from Berkeley.) Page 262.

Figures 1, 6, 7, and 8 drawn by Mary H. Swift; figs. 2, 3, 4, and 5 by A. J. Heindl.

*Aesculus californica* Nutt.

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PLATE 80.

## EXPLANATION OF PLATE 80.

*Acer macrophyllum* Pursh (Big-leaf Maple). Figure 1, leaf (×½), (material from Berkeley); fig. 2, samara (×1). Pages 264, 266.

*Acer glabrum* Torr. (Sierra Maple). Fig. 3, leaf (×½); fig. 4, samara (×1). Page 268.

*Acer circinatum* Pursh (Vine Maple). Figure 5, leaf (×½); fig. 6, samara (×1). (Material from Rio Del, Eel River.) Page 267.

*Acer negundo* var. *californicum* Sarg. (Box Elder). Figure 7, leaf (×½); fig. 8, samara (×1). Page 269.

Figures 1, 2, 4, and 6 drawn by A. A. Lawson; fig. 5 by A. J. Heindl.

Leaf and fruit types of California maples.

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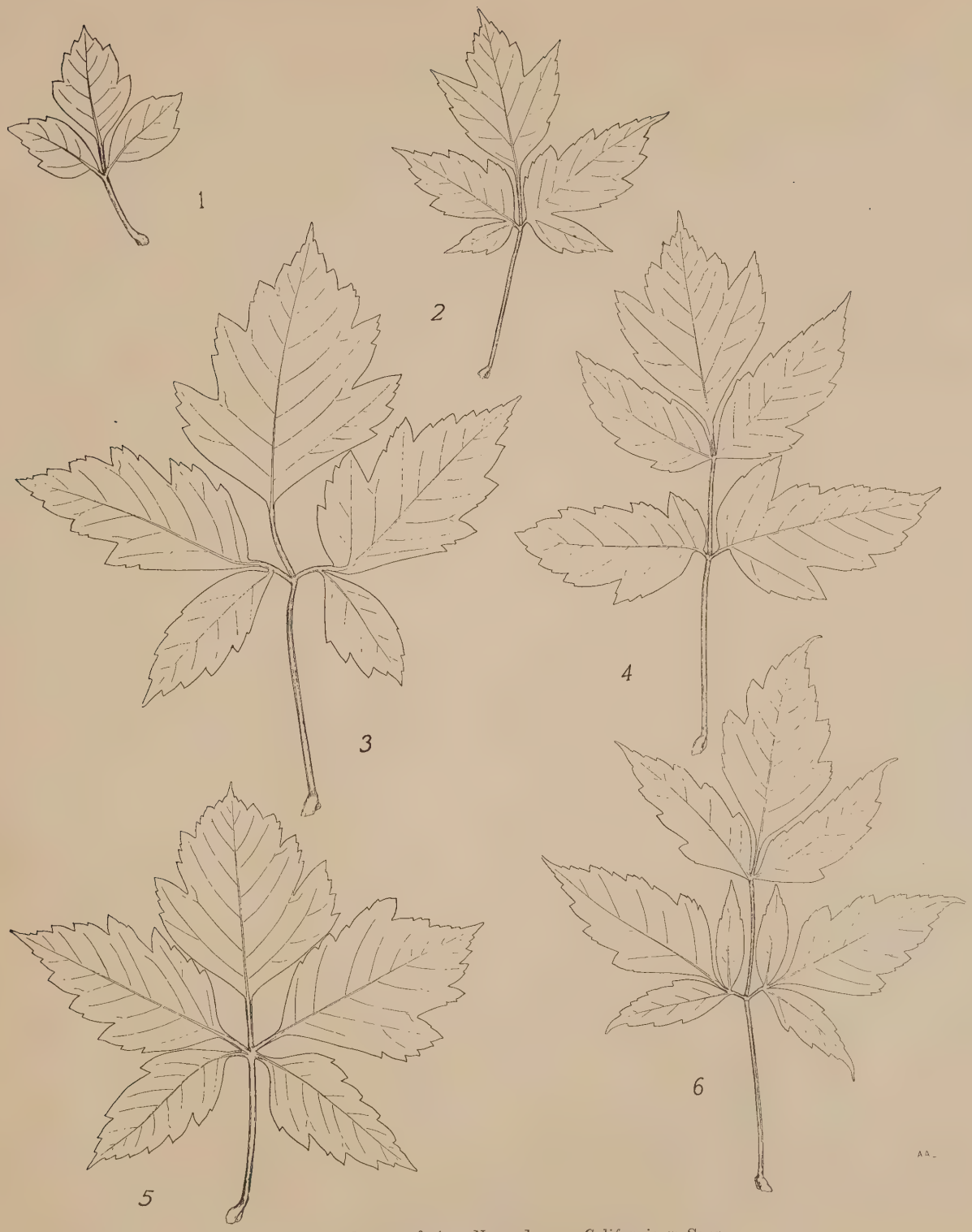
PLATE 81.

## EXPLANATION OF PLATE 81.

Leaf-variation in *Acer negundo* var. *californicum* Sarg. (Box Elder). Figure 1, 3-foliolate leaf, the lateral leaflets with a strong tooth on lower side; fig. 2, lateral leaflets deeply lobed on lower side; fig. 3, leaf with five distinct leaflets but the two extra leaflets arising palmately; fig. 5, leaf with five leaflets, palmately arranged (compare with Buckeye leaf in plate 79); fig. 4, terminal leaflet replaced by three leaflets; fig. 6, all three leaflets replaced by three, making nine. (Material from the lower Russian River, *J. B. Davy,* except that for fig. 4, which is from Santa Barbara, *G. W. Dunn.*) Page 269.

Drawn by A. A. Lawson.




Variation in leaves of *Acer Negundo* var. *Californicum* Sarg.

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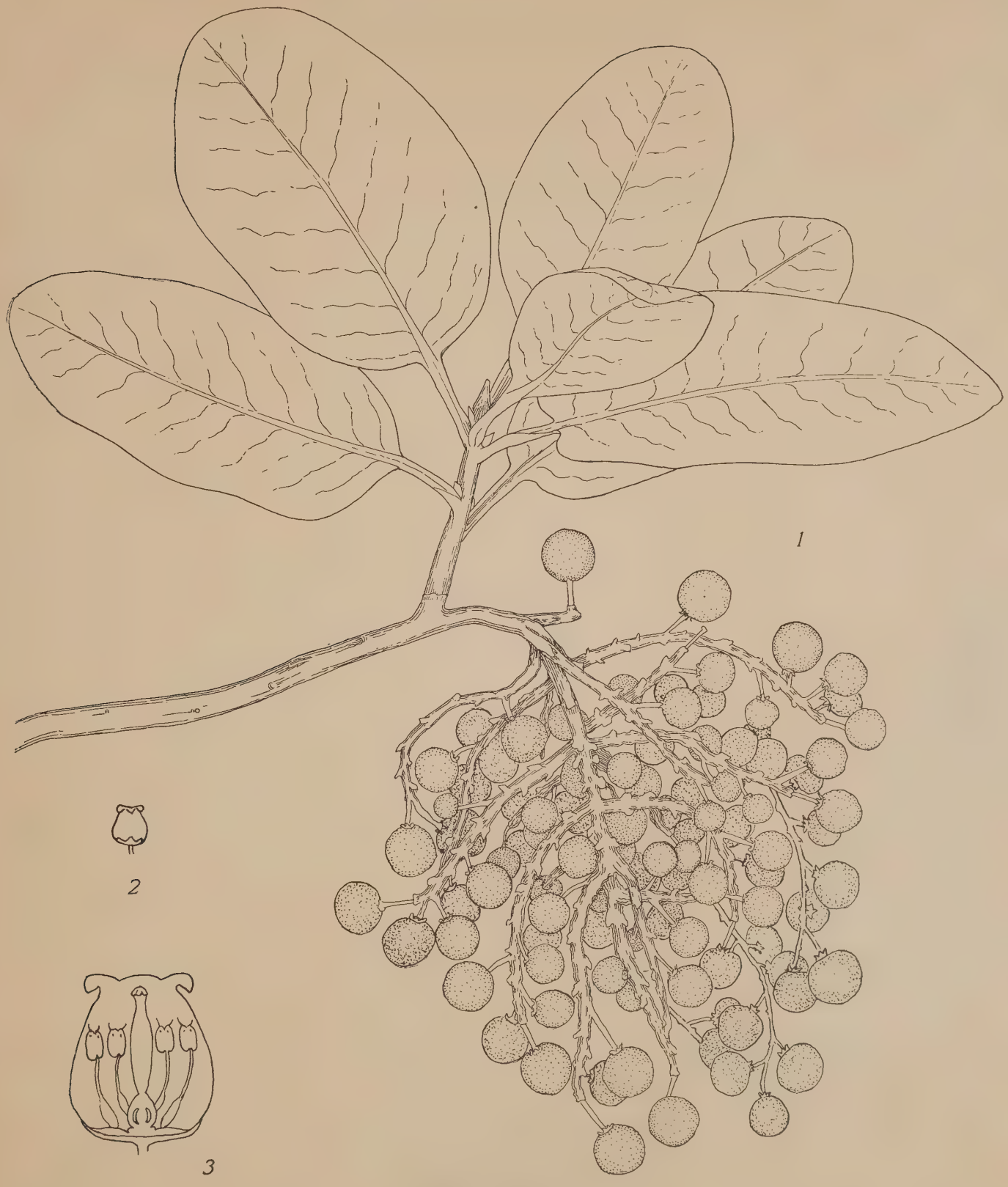
PLATE 82.

## EXPLANATION OF PLATE 82.

*Arbutus Menziesii* Pursh (Madrona). Figure 1, fruiting branchlet (×1); fig. 2, flower (×1); fig. 3, longitudinal section of flower (×4). (Material from St. Helena.) Page 272.

Figure 1 drawn by A. A. Lawson.




*Arbutus Menziesii* Pursh.

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PLATE 83.

## EXPLANATION OF PLATE 83.

*Arbutus Menziesii* Pursh (Madrona). Trunk of mature individual, characteristic of trees in the woods of Mendocino and Humboldt; trunk diameter, 6 feet; bark scaling off superficially in small, thin plates. Page 273.

Photograph by P. E. Goddard.

Trunk of *Arbutus Menziesii* Pursh.

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PLATE 84.

## EXPLANATION OF PLATE 84.

*Sambucus glauca* Nutt. (Black Elderberry). Figure 1, flowering branch (× ⅔) ; fig. 2, flower (× 4). (Material from Berkeley.) Page 282.

Figure 1 drawn by Mary H. Swift.

*Sambucus glauca* Nutt.

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PLATE 85.

## EXPLANATION OF PLATE 85.

*Sambucus racemosa* var. *callicarpa* Jepson (Red Elderberry). Figure 1, flowering branch (× ¾) ; fig. 2, flower (× 6). (Material from cultivated tree brought from near Olema.) Page 283.

Figure 1 drawn by Mary H. Swift.

*Sambucus racemosa* var. *calicarpa* Jepson.

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MAP 1.

MAP 1.

*Sequoia gigantea* Dec. Northern Groves. The seven northern groves are small well-defined bodies widely isolated from each other, except certain ones which occur in pairs. In order from north to south they are as follows: North Grove, Calaveras Grove, Stanislaus Grove, Tuolumne Grove, Merced Grove, Mariposa Grove, Fresno Grove.

MAP 2.

MAP 2.

*Sequoia gigantea* Dec. Southern Groves. The twenty-four southern groves consist of groves and forests of very variable size or extent with comparatively narrow gaps between the groves. The groves from north to south are as follows: Dinkey Grove, Converse Basin Forest, Boulder Creek Forest, General Grant Forest, Redwood Cañon Forest, North Kaweah Forest, Giant Forest, Harmon Meadow Grove, Cliff Creek Grove, Mineral King Forest, Lake Cañon Grove, Mule Gulch Grove, Homer Peak Forest, South Kaweah Forest, Dillon Forest, Tule River Forest, Pixley Grove, Putnam Mill Forest, Fleitz Forest, Freeman Valley Forest, Kern River Groves, Kessing Groves, Indian Reservation Forest, Deer Creek Grove.

MAP 3.

MAP 3.

Map of California. Designed to indicate the mountain chains, valleys and river systems of most importance in relation to plant distribution; supplemented in particular by an indication of county boundaries since the counties are so commonly quoted in the text.

# SUBJECT INDEX.

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# GEOGRAPHICAL INDEX.

This index includes all the mountain ranges, rivers, and valleys of physiographical importance in the State with such other localities as are of special interest, or which derive their importance from being quoted in the text as stations in indicating geographical distribution of species. The first numbers refer to the map; the second numbers are page numbers of the text where the locality finds citation. If a given locality is not marked on the map, the map numbers indicate its approximate location.


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A stream draining Livermore Valley and the northerly part of the Mount Hamilton Range.

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Bachelor Valley (D 10), 206, 265.
At the northerly end of Clear Lake, Lake County.

"Bald Hills" (D 4-10), 16, 210, 213, 236.
General descriptive term applied to any of the mountains of Mendocino and Humboldt counties on the inner side of the Redwood Belt, where occasional open spaces amongst the Douglas Firs and broad-leaved trees of the region appear on the summits, or ridges.

Banner (U 29), 117.
Village north of Cuyamaca, near center of San Diego County.

Bartlett Creek (E 10), 159.
Tributary of Cache Creek in northern Lake County.

Bay Region (E-G 12-16), 274.
Region of San Francisco Bay, including the counties of Marin, Sonoma, Napa, Solano, Contra Costa, Alameda, Santa Clara, San Mateo, and San Francisco.

Bear River Range (B 6), 150.
The Bear River Mountains lie between the lower (main) Eel River and Bear Creek, which empties into the Pacific Ocean near Cape Mendocino.

Bear Valley, Marin County (D 13), 96, 98, 244.
A locality botanized by Kellogg and Bolander in early days.

Bear Valley, Nevada County (J 9), 175, 265.
4,500 feet altitude. A locality botanized by Hartweg in 1845, and Jepson in 1898. A third "Bear Valley" of California botanical importance is in the San Bernardino Mountains at 7,000 feet altitude, and has been the subject of field study by Parish and by Hall.

Bells Spring Ridge (C 7), 166, 212.
Long north and south ridge of very uniform height (4,000 to 5,000 feet) lying between the main Eel River on the east and the South Fork Eel River on the west; a northerly continuation of the Blue Rock Ridge.

Berkeley (F 14), 49, 55, 175, 176, 262.
City in Alameda County.

Hills (F 14), 47, 244, 248, 252, 272.
Northerly and southerly range extending from near San Pablo south to Kohler Pass opposite Round Top.

Big Arroyo (O, P 19), 76.
Tributary of the Kern River heading near the Kaweah Peaks.

Big Oak Flat (J 14), 206.
In Tuolumme County, old stage station on the Yosemite Road.

Big River (B 9), 55, 110.
Mendocino County, heading near the divide of the outer Coast Range and emptying into the Pacific Ocean.

Big Sur River. *See* Sur River.

Blocksburg (C 6), 245.
Village in southeastern Humboldt County.

Blue Cañon (I 10), 19.
Station on the Southern Pacific Railroad on the western slope of the Sierra Nevada.

Blue Lakes (D 10), 206.
Series of three lakes in Lake County.

Blue Rock Ridge (C 8), 222, 265.
Long north and south ridge of very uniform height (4,000 to 5,000 feet), lying between the main Eel River on the east and the South Fork Eel River on the west.

Bolinas Bay (E 14), 283.
Marin coast.

Bon Tempe Ranch (E 14), 274.
Locality near Lagunitas, Mount Tamalpais.

Brea Cañon (R 27), 193.
Cañon at the north end of the Santa Ana Mountains on the westerly slope.

Bridgeport (M 13), 94.
Town in Mono County.

Bubbs Creek (O 17, 18), 23, 76, 94, 108, 176, 189, 201, 252.
Tributary of the South Fork Kings River heading in the Sierra Nevada divide.

Bullfrog Lake (O 17), 183.
Sierra Nevada near Kearsarge Pass, altitude 10,634 feet.

Butte County (G 8, 9), 178. *See also* Chico.

Butts Cañon (E 11), 159.
Pass between Pope Valley and Coyote Valley, east side of the Napa Range.

Cache Creek (G 11), 10, 177.
Tributary of the Sacramento River, draining Clear Lake.

Cahto (C 9), 166.
Village in central Mendocino County.

Cajon Pass (R 25), 40.
Pass from San Bernardino to the Mohave Desert between the Sierra Madre and the San Bernardino Mountains.

Calaveras County (J 13), 47, 140, 180.
River, tributary of the San Joaquin River, heading in the Sierra Nevada.

California, Lower, 162, 218, 260.
Baja California, a state of the Republic of Mexico.

Southern (J-Z 24-31), 10, 20, 29, 120.
The eight southern counties of California, namely, Santa Barbara, Ventura, Los Angeles, Orange, San Diego, Imperial, Riverside, and San Bernardino.

Camp Grant (B 6), 244, 265.
Stage station and former military post in the Eel River Valley on the lower Eel River.

Campo (U 31), 219.
Village on the Mexican Boundary near the middle of San Diego County.

Cape Mendocino (A 6), 42, 110, 129, 131, 150.
Promontory on the Humboldt coast.

Carmel River (G 18), 180, 188.
Draining the northern Santa Lucia Mountains and emptying into the Pacific Ocean near Monterey.

Carson Pass (K 11), 95.
Pass over Sierra Nevada south of Lake Tahoe, at headwaters of West Fork Carson River, near Round Top, altitude, 8,100 feet.

River (L 11), 95.
Stream heading on the east slope of the Sierra Nevada and emptying into Carson Lake, Nevada.

Caspar (B 9), 182.
Redwood mill town on the Mendocino coast.

Castella (F 4), 112.
Village in the Sacramento River Cañon near Dunsmuir.

Catalina Island, *see* Santa Catalina.

Cedar Creek (N 18), 262, 265.
Mountain stream northerly from Ash Peaks, Kaweah Basin.

Mountain (G 15), 158.
Northerly part of the Mount Hamilton Range, south of Livermore Valley, altitude, 3,670 feet.

Cedros Island, 97.
Island on the Lower California coast; spelled Cerros by the U. S. Geographic Board.

Chagoopah Plateau (O, P 19), 76.
Lying between the Kern Cañon and the Little Kern River, altitude, 10,000 to 11,000 feet.

Channel Islands, *see* Santa Barbara Islands.

Charleston Mountains (V 19), 75, 77, 93, 163, 280.
Range in southern Nevada, its southern spur almost or quite crossing the California line. This range is, however, in Nevada, even though the text may in places seem literally to read otherwise.

Chico (G 8), 101, 206.
Town in Butte County in the upper Sacramento Valley.

Chilnualna Trail (M 15), 183.
Trail from Wawona to Grouse and Crescent lakes, Sierra Nevada.

Chubb Cave, *should read* Cluffs Cave, *which see.*

Chuckawalla Bench (X, Y 28, 29), 260, 261.
Mesa at base of Chuckawalla Mountains, north side of Colorado Desert.

Clear Lake (D, E 10), 17.
Body of water in Lake County.

Valley (D 10), 16.
Valley southerly and westerly from Clear Lake, Lake County; also called Big Valley.

Cloverdale (D 11), 226, 245, 249.
Town on the Russian River in northern Sonoma County.

Cluffs Cave (O 19), 23, 262.
On South Fork Kaweah River.

Coast Ranges, 9, 20, 22, 78, 87, 88, 182, 197, 236.
Here used for the mountain ranges lying between the Great Valley of California and the Pacific Ocean, blending on the north with the Oregon Coast Range and on the south with the mountains of Southern California.

Inner Coast Range, 14, 17.
The innermost range, lying next to the Great Valley, descriptive term including the Yollo Bolly Mountains, Vaca Mountains, Mount Diablo, Mount Hamilton and San Carlos ranges.

North Coast Ranges, 10, 16, 17, 78.
The Coast Ranges north of San Francisco Bay.

Inner North Coast Range, 122.
The Yollo Bolly Mountains, Vaca Mountains, etc.

South Coast Ranges, 10, 12, 39.
The ranges lying south of South San Francisco Bay.

Inner South Coast Range.
The Mount Diablo Range, Mount Hamilton and San Carlos ranges.

Cobb Mountain (E 11), 17, 71, 159.
Mountain just north of Mount St. Helena in the Mayacamas Range.

Colorado Desert (V-Y 28-30), 20, 172, 178, 189, 258, 260, 281.
Desert region lying between the San Jacinto Range and the Colorado River, and south of the Chuckawalla Mountains.

River (Z 27), 187, 257, 270.
Forming the boundary between Southern California and Arizona.

Colusa County (F 10).
West side of Sacramento Valley.

Comptche (C 10), 175, 182.
Road station in west-central Mendocino County.

Contra Costa County (F, G 14), 55, 193, 244, 253.
*See also* Mount Diablo *and* Walnut Creek.

Converse Basin (N 18), 23, 58, 146.
Near Millwood, basin of the upper waters of Converse Creek, tributary of the main Kings River.

Cordelia (F 13), 253.
Village in Green Valley, western Solano County.

Coso Mountains (Q 20), 170.
Desert range south of Owens Lake.

Cosumnes River (H 12), 232.
Tributary of the Sacramento River, heading in the high Sierra Nevada.

Cottonwood Creek (E 6), 177, 178, 186, 216, 262, 265.
In Tehama County, tributary of the Sacramento River. Its principal forks are the Middle Fork, Dry Creek, Cold Fork, Salt Creek Fork, and South Fork.

Trail (P 18), 94.
Trail from Lone Pine to Volcano Creek, southern Sierra Nevada.

Coyote Cañon (U 28), 172.
South of Santa Rosa Mountain opening towards the Colorado Desert.

Valley (E 11), 159.
Near Middletown, southwestern Lake County.

Crescent City (B 2), 31, 110, 138.
Del Norte coast.

Crescent Lake (M 15), 184.
Madera County, about 7 miles easterly from Wawona, altitude, 8,500 feet.

Cummings (C 8), 166.
Stage station in northern Mendocino, southerly slope of Blue Rock Ridge.

Cuyamaca Mountains (U 29), 20, 120, 148, 198, 232, 233, 248.
Central San Diego County, the highest peak of which is 6,208 feet high and often referred to simply as Cuyamaca. Also spelled Cuiamaca.

Cypress Point (F 18), 155.
Headland south of Point Pinos, Monterey peninsula.

Death Valley (S, T 19), 163, 257, 258.
Desert valley between the Panamint and Funeral mountains.

Deer Creek, Tehama County (G 7), 142.
Tributary of the Sacramento River, heading in the Sierra Nevada.

Deer Creek, Tulare County (N 21), 186.
Stream in the upper San Joaquin, emptying into Tulare Lake and heading in the Greenhorn Range.

Del Norte County (B 1, 2), 108, 110, 121, 129, 132, 137, 152, 161, 166, 182, 237.

Desolation Valley (K 10), 161.
Alpine Valley southwest of Lake Tahoe, altitude 8,200 feet.

Devil's Backbone (C 4), 103, 267.
Ridge between Trinity Summit and Salmon Summit.

Donner Lake (K 9), 268.
Nevada County, altitude, 6,095 feet.

Pass (K 9), 182, 200, 268.
Nevada County, altitude, 7,100 feet.

Dulzura (T 31), 158.
Village, southwestern San Diego County.

Duncan Mills (D 12), 168.
Village on Russian River, Sonoma County.

Eel River (C, D 8, 9), 131, 134, 138, 186, 188, 244, 252, 265, 266.
The various forks of the Eel River are very confusing in their nomenclature and ought to be renamed. The great westerly fork which empties into the main river at Dyerville in Humboldt County is universally known as South Fork Eel River and so indicated on the maps. From Dyerville up the main Eel River to eastern Mendocino County is a long distance. By this time we have forgotten the great fork on the lower Eel River and we have in order the North Fork Eel, Middle Fork Eel, and South Fork Eel. These forks are universally known as such in the region, and are so indicated on the maps. There are thus two separate and distinct "South Fork" branches of this one river. Moreover there are such geographical absurdities as South Fork of the Middle Fork, etc.

Eldorado County (I, J 11), 47, 218, 224.

El Toro Peak (U 28), 75, 93.
Highest peak of Santa Rosa Mountain, Riverside County, altitude, 8,705 feet. *See also* Santa Rosa Mountain.

Elk (B 10), 98, 244.
Mill town on the southern Mendocino coast, locally known also as Greenwood.

Creek (B 10), 106, 162, 166.
Coast stream in southern Mendocino County.

Mountain (D 9), 231.
Between Bachelor and Gravelly valleys, northern Lake County.

Emigrant Gap (J 9), 252.
Pass above Bear Valley, Nevada County.

Empire Creek (J 11), 167.
Eldorado County.

Eshom Valley (N 18), 206.
On Eshom Creek, North Fork Kaweah River, altitude, 3,400 feet.

Eureka (A 5), 18, 42, 138, 182, 254.
City on the Humboldt coast.

Fair Oaks (H 12), 215.
Sacramento County. There is also a Fair Oaks in San Mateo County and in Los Angeles County.

Fallbrook (S 28), 49.
Village in northwestern San Diego County.

Farewell Gap (O 19), 183.
Pass from the Little Kern River to the East Fork Kaweah River, altitude, 10,588 feet.

Feather River (G, H 9), 168, 269.
Tributary of the Sacramento River heading in the high northern Sierra Nevada.

Ferndale (A 5), 188.
Town in western Humboldt County.

Fort Bidwell (K 2), 253.
Indian and old military station in northwestern Modoc County.

Fort Bragg (B 9), 98, 110, 154.
Town on the Mendocino coast.

Fort Mohave (Y 23), 178.
Old military station above the Needles on the Arizona side of the Colorado River.

Fort Tejon (O 24), 204, 262.
Abandoned military post at the west end of the Tehachapi Mountains in Tejon Pass.

Four Creeks Country (M, N 19), 207.
Region of the Kaweah Delta where the Kaweah River breaks up into a network of streams on the valley floor of the San Joaquin.

Frazier Mountain (N 24), 94.
In northeastern Ventura County, altitude, 8,026 feet.

French's (B 7), 240.
Road station in northwestern Mendocino County.

Fresno (L 18), 42.
Town in Fresno County. *See also* Millwood.

River (L 17).
Tributary of the San Joaquin River heading in the Sierra Nevada.

Gabilan Range (H 18), 90.
Southerly continuation of the Santa Cruz Range from Pajaro River to San Lorenzo Creek.

Garvanza (P 26), 56.
Station near Los Angeles.

Giant Forest (O 18).
Plateau between the Marble Fork and the Middle Fork of the Kaweah River, altitude 6,500 to 7,000 feet; forested with *Sequoia gigantea, Pinus ponderosa, Pinus Lambertiana* and *Abies concolor.*

Gilroy (G 17), 189, 278.
Town in southern Santa Clara County.

Valley (G 17), 44, 188.
In southern Santa Clara County.

Glenbrook (E 11), 159, 283.
Road station in southwestern Lake County.

Glenn County (F 8, 9), 162.

Golden Trout Creek, *see* Volcano Creek.

Gordon Valley (F 12), 194.
Eastern Napa County, north of Suisun Valley.

Grand Island (G 13), 269.
Lower Sacramento River.

Grapevine Mountains (Q, R 16), 75, 93, 163.
Desert range on the California-Nevada boundary north of Death Valley.

Gravelly Valley (D 9), 186.
Northern Lake County on South Fork Eel River.

Great Valley, 10, 11, 18, 29, 44, 87.
Comprising the Sacramento and San Joaquin valleys.

Great Western Divide (O 18, 19).
The divide between the Kaweah River and the upper Kern River.

Greenwood, 244. *See* Elk.

Guadalupe Island, 101, 220.
Off the coast of Lower California. Not "San Guadaloupe Island."

Gualala River (C 11), 98.
Western Sonoma County, emptying into the Pacific Ocean.

Guerneville (D 12), 269.
Town in western Sonoma County on the Russian River.

Harding Landing (H 10), 177, 269.
Steamboat landing on the Feather River between Sacramento and Marysville.

Hetch-Hetchy Valley (L 14), 167, 222.
Cañon-valley on the Tuolumne River, altitude 3,700 feet. The cañon floor is remarkable for its California Black Oak groves.

Hot Springs Valley (U 29), 265.
Near Warner, northern San Diego County.

Howell Mountain (F 12), 17, 78, 131, 175, 177, 215, 244.
East of St. Helena in the Napa Range.

Humboldt County (B 5), 16, 78, 103, 106, 110, 121, 135, 137, 148, 151, 178, 181, 188, 189, 199, 201, 210, 213, 222, 238, 245, 246, 266, 273, 275.
Often referred to simply as Humboldt, an abbreviation often practiced with the names of California counties.

"Prairies", 16.
Small open spaces in the Humboldt forest.

Hupa Valley (C 4), 178, 222, 274.
In the cañon of Trinity River, northern Humboldt County.

Hy-am-pum Mountain (C 5), 168.
Western Trinity County.

Imperial County (X 29).
Southeastern California in the Colorado Desert.

Indian Creek (D 1), 112.
Tributary of the Klamath River at Happy Camp.

Indian Wells (U 27), 172.
Colorado Desert west of Indio.

Indio (U 27), 20, 261.
Railway station, northwestern arm of Colorado Desert.

Inglenook (B 9), 96.
Village on Mendocino coast.

Inverness (D 13), 99, 243, 263, 283.
Village on Point Reyes peninsula.

Inyo County (R 18), 75, 190.
Mountains (Q 17, 18), 77, 93, 163.
Range east of Independence.

Jackson Valley (C 9), 31, 240, 252.
Northwestern Mendocino County.

Jolon (I 20), 215.
Old stage station in the San Antonio Valley, southern Monterey County.

Julian (U 29), 93, 117, 243.
Village, central San Diego County.

Junction Meadow (O 18), 23, 191.
Kern Cañon, at junction of Kern-Kaweah fork, east fork and main river, altitude 8,100 feet.

Kaweah (N 19), 216.
Road station on North Fork Kaweah River.
Basin (N, O 18, 19), 47, 76, 218, 243, 251, 263.
The basin or country of the five forks of the Kaweah River.

Delta (M, N 19), 10, 186, 207.
Area of the San Joaquin plains subject to winter overflow by the dividing network of the Kaweah River as it enters the plain from the mountains.
River (N 19), 87, 140, 142, 178, 198, 207, 208.
Rising in the Great Western Divide and emptying into Tulare Lake. It has five forks: North Fork, 262, 265, 283; Marble Fork, 23, 182; Middle Fork; East Fork; South Fork, 167, 186.

Kearsarge Pass (P 17), 76, 233.
Pass from Kings Cañon to Independence, southern Sierra Nevada, altitude 11,823 feet.

Kelsey Trail (C 2), 112, 152, 166.
Trail across the Klamath Range from Crescent City to Cottage Grove on the Klamath River.

Kelseyville (D 10), 206.
Village in central Lake County.

Kenny (B 7), 240.
Road station on the Coast Road in northwestern Mendocino County.

Kern County (O 23), 218, 257.
River (O 22), 17, 23, 69, 94, 142, 176, 188, 191, 222, 252, 268.
Emptying into Buena Vista and Kern lakes, having its source about Mounts Whitney and Tyndall and the Kaweah peaks, the upper portion of its course from Volcano Creek to Junction Meadow being known as Kern Cañon. The Little Kern, p. 69, is one of the upper westerly forks heading about Farewell Gap. Kern Valley, p. 170, is on the lower river about Kernville.

Kernville (P 21), 162.
Village in the southern Sierra Nevada on the Kern River.

Kings Cañon (O 17), 188, 222.
The cañon of the South Fork of Kings River.
River (M 18), 17, 87, 108, 140.
Tributary of the San Joaquin River, heading in the high Sierra Nevada. It has three forks, the Middle Fork, North Fork, p. 184, and South Fork, pp. 76, 252.

Kings Mountain, San Mateo County (F 16), 182.
Southern San Mateo County.

King's Mountain, Humboldt County (A 7), 273.
On the southern Humboldt coast.

Kinsley (L 15), 103, 269.
Village in Mariposa County.

Klamath Range (C 2), 104, 108, 112, 152, 166, 211, 219.
The mountains or range forming the boundary between Del Norte and Siskiyou counties.
River (C 2), 31, 178, 188.
Outlet of Klamath Lake on the northern boundary of California, and running westerly through northern California to the Pacific Ocean.

Knights Valley (E 11), 78.
In Sonoma County under the west side of Mount St. Helena.

Lafayette Creek (F 14), 193.
Tributary of Walnut Creek, Contra Costa County.

Lagoon Valley (G 13), 47.
Western Solano County, south of Vaca Valley.

Lagunitas Lake (E 14), 274.
North side of Mount Tamalpais.

Lake County (E 10), 120, 159, 162, 178, 180, 186, 188, 231, 265, 283.

Larkin Station, 93.
Road station in eastern San Diego County.

Lassen Buttes (H 6), 160.
The series of buttes in the southeastern corner of Shasta County, the highest of which is Lassen Peak, 10,437 feet.

County (I, J 5), 201.

Laytonville (C 8), 166.
Road station in northern Mendocino County.

Lemon Cove (N 19), 178.
Village in the Sierra Nevada foothills of Tulare County.

Limekiln Creek (N 18), 23, 58, 262.
A lower north tributary of Kaweah River.

Little Lake Valley (D 9), 208.
Central Mendocino County about Willits.

Little Sur River. *See* Sur River.

Lone Pine (Q 18), 94.
Village in Owen's Valley, Inyo County.

Long Valley (C 8), 16, 78, 189.
North central Mendocino County.

Los Angeles (P 26), 255.
City in Los Angeles County.

County (P 25), 49, 273.

Lower California, *see* California, Lower.

Madera County (L 17). *See also* Crescent Lake.

Mad River (C 5), 152.
Stream paralleling the Eel River, emptying into the Pacific Ocean and heading near Middle Yollo Bolly.

Marble Mountain (D 2), 17, 39, 69, 76, 82, 108, 112, 184, 211, 219, 268.
Western Siskiyou County.

Marin County (E 13), 96, 101, 168, 182, 199, 243, 265, 274, 283.

Mariposa County (L 15), 103, 162, 180, 183, 184, 269.

Marsh's Ranch (G 14), 274.
Old-time settlement at eastern base of Mount Diablo.

Marysville Buttes (G 10), 177.
Rising like islands out of the Sacramento plain in Sutter County. The South Butte is 2,128 feet high.

Matilija River (M 25), 236.
Tributary of Ventura River (Ventura County), which empties into the Pacific Ocean at Ventura.

Mattole River (B 6), 110, 129, 189, 222, 263, 265, 273.
Stream of southwestern Humboldt County emptying into the Pacific Ocean south of Cape Mendocino.

Mayacamas Range (D 10), 148.
The mountains east of Ukiah Valley from Cobb Mountain and Geyser Peak north to Cow Mountain.

Melburne (C 10), 182.
Road station between Mendocino City and Ukiah.

Mendocino Coast (B 9), 99, 244.

County (C 9), 16, 28, 49, 78, 96, 106, 110, 121, 166, 181, 182, 186, 188, 189, 199, 212, 222, 231, 237, 238, 239, 240, 246, 252, 266, 273, 274, 283.
Often abbreviated simply to Mendocino, as similarly with other counties. *See also* "Bald Hills."

"White Plains" (B 9), 84, 96, 154.
Mesa-like flat or pine barren country on the Mendocino coast extending from near Inglenook south to Big River.

Merced County (J 16).
Lying chiefly on the floor of the San Joaquin Valley.

Merced River (J 16), 141.
Tributary of the San Joaquin River, heading in the high Sierra Nevada.

Mill Creek Cañon (D 10), 199, 222, 224.
Cañon of the Mayacamas Range near Ukiah.

Mill Valley (E 14), 133.
Southeast base of Mount Tamalpais.

Millwood (N 18), 23.
Mill town in the Sierra Nevada of Fresno County.

Mineral King (O 19), 144, 191, 252.
Village on the East Fork Kaweah River, altitude 7,831 feet.

Mission, Pala (S 28), 125.
Northern San Diego County, east of Fallbrook on the San Luis Rey River.

La Purisima (J 24), 96.
Lower San Inez River, near town of Lompoc, Santa Barbara County.

San Antonio (H 20), 85, 125.
Southern Monterey County on the San Antonio River.

San Juan Bautista (G 17), 90.
Northwestern San Benito County.

Santa Inez (K 25), 95, 226.
North central Santa Barbara County on Santa Inez River.

Mitchell Cañon (G 14), 89.
North slope of Mount Diablo.

Modesto (I 15), 12.
Town in the San Joaquin Valley.

Modoc County (I 2), 104, 160, 184, 201, 253.

Mohave Desert (S 22), 95, 170, 257, 258, 281.
Lying between the Tehachapi Range and the San Bernardino Mountains and extending east to the Colorado River.

River (T 23), 186.
Rising in the San Bernardino Mountains and flowing easterly to a sink in the Mohave Desert.

*See also* Fort Mohave.

Mokelumne River (I 13), 167, 232.
Tributary of the Sacramento River, rising in the high Sierra Nevada.

Mono County (N 14), 75, 181, 184.

Pass (M 14), 161, 184.
Pass from Tuolumne Meadows to Mono Lake, altitude 10,599 feet.

Monterey (G 18), 96, 100, 130, 132, 138, 155, 180, 263.
Town in northern Monterey County on the Pacific Ocean.

County (H 20), 102, 124, 129, 139, 189.

Moraga Pass (F 14), 162.
Pass from San Leandro Creek to Moraga Valley.

Ridge (F 14), 55, 103.
East of the upper San Leandro Creek, south of Round Top.

Valley (F 14), 13, 177.
Southwestern Contra Costa County.

Mount Brewer (O 18), 185.
Peak in the southern Sierra Nevada, altitude 13,577 feet.

Mount Dana (M 14), 185.
Peak in the central Sierra Nevada, altitude 13,050 feet.

Mount Diablo (G 14), 13, 86, 88, 89, 162, 188, 192, 193, 219, 226, 231, 248, 262, 265, 272, 274.

Range (G 14), 79, 87, 132, 148, 275.
The range of hills from Concord southeasterly to Livermore Pass, of which Mount Diablo is a dominant mass. On old maps one finds the term Mount Diablo Range applied to the whole of the inner South Coast Range from Mount Hamilton southward to the San Carlos Range.

Mount Goddard (O 17), 184, 185.
On divide between Middle Fork Kings River and South Fork San Joaquin River, altitude 13,550 feet.

Mount Hamilton (H 16), 231.
Santa Clara County, altitude 4,209 feet.

Range (H 16), 79, 86, 87, 148, 248, 272.
Extending from the Livermore Pass and the Livermore Valley south to Pacheco Pass.

Mount Hood (E 12), 103, 182.
Eastern Sonoma County; Mount Hood Range, 131, 210, lies between Napa and Santa Rosa valleys and extends from San Pablo Bay north to Knights Valley.

Mount Lola (J 9), 184.
Sierra Nevada, Nevada County, altitude 9,167 feet.

Mount Lyell (M 15), 185.
Sierra Nevada, Yosemite National Park, altitude 13,090 feet.

Mount Pinos (N 24), 75, 87, 94, 120, 236, 251.
On northern boundary of Ventura County, altitude 8,826 feet. This should not be confused with Pine Mountain in west-central Ventura County.

Mount St. Helena (E 11), 71, 103, 148, 224, 231, 271.
Northern Napa County, altitude 4,343 feet; Mount St. Helena Range (pp. 47, 78, 88, 167, 273) is a general term sometimes in use to cover both the Napa and Mayacamas ranges.

Mount St. John (E 9), 164.
Near Snow Mountain, north of Clear Lake.

Mount San Carlos (J 19), 162, 183.
Southern San Benito County, altitude 4,977 feet; San Carlos Range (p. 183) is the inner South Coast Range from Panoche Pass to Warthan Creek.

Mount San Gorgonio (T 26), 191.
San Bernardino Mountain, altitude 11,485 feet. Also called "Grayback."

Mount San Pedro Martir, 29, 120, 191, 231.
Peninsula of Lower California, a botanical station important as marking the southernmost limits of the *Pinus Lambertiana, Pinus Murrayana, Populus tremuloides,* and other Californian trees.

Mount Shasta (F 3), 39, 69, 73, 81, 82, 103, 104, 108, 114, 122, 161, 164, 166, 200, 201, 231, 237, 241, 252, 272.
Siskiyou County, altitude 14,350 feet; treated botanically as belonging to the North Coast Range area.

Mount Silliman (O 18), 76.
Sierra Nevada, Tulare County, altitude 11,188 feet.

Mount Tamalpais (E 14), 133, 137, 158, 167, 182, 212, 231, 273.
Marin County, altitude 2,586 feet.

Mount Whitney (P 18), 17, 73, 76, 185.
Southern Sierra Nevada, altitude 14,501 feet.

Mount Wilson (P 26), 273.
San Gabriel Range of the Sierra Madre, altitude 5,700 feet.

Nacimiento River (H 21), 215, 217.
Tributary of the Salinas River, with sources in the Santa Lucia Mountains; sometimes marked Sierra River on maps.

Napa County (F 12), 159, 192. *See also* St. Helena, Pope Valley, Howell Mountain.

Range (F 12), 115, 219, 265.
East of Napa Valley, and extending from Jameson Cañon and Elkhorn Peak north to Mount St. Helena.

Valley (F 12), 16, 78, 88, 131, 178, 186, 226, 233, 252, 265, 275.
Lying between the Mount Hood and Napa ranges.

Needles (Y 24), 20, 270.
Town on the Colorado River in San Bernardino County.

Nevada County (I 10), 175, 177, 184, 265.

New River (C 4), 274.
Northwestern Trinity County, northern tributary of the Trinity River.

Niles (F 15), 269.
Town in southwestern Alameda County.

Cañon (F 15), 248.
The cañon of Alameda Creek, east of Niles.

Oakland Hills (F 14), 132, 181, 265, 272.
The range east of Oakland from Kohler Pass south to the Redwood Creek Pass.

Ojai Valley (M 25), 192, 204, 206, 226.
Western Ventura County.

Olanche Mountain (P 19), 76.
Peak in the southern Sierra Nevada, altitude 12,135 feet.

Olema (D 13), 175, 243.
Village in western Marin County.

Orange County (Q 27), 50, 178.

Owens Lake (Q 19), 170, 279, 280.
Inyo County.

Valley (Q 18), 201, 233.
Lying between the Sierra Nevada and the Inyo Range, through which Owens River flows.

Oxnard (N 26), 179.
Town in southern Ventura County.

Pacheco (F 14), 178.
Village in northern Contra Costa County.

Pacific Grove (F 18), 182.
Town on the Monterey peninsula.

Pajaro (G 17), 41.
Town on the lower Pajaro River.

River (G 17), 129.
Empties into Monterey Bay and has its sources in the inner Coast Range about Pacheco Peak.

Valley (G 17), 129.
Along the lower Pajaro River west of the Santa Cruz Range.

Palm Springs (T 27), 172, 260.
East base of Mount San Jacinto.

Palo Alto (F 15), 248.
Town in Santa Clara County.

Palomar (T 28), 20, 117, 120, 189, 233, 248, 252, 273.
Mountain in northern San Diego County; often called Smith Mountain.

Panamint Mountains (R 18), 75, 77, 163, 280.
Northwesterly from Death Valley.

Papermill Creek (D 13) 168.
Stream in Marin County emptying into Tomales Bay.

Paso Robles (J 21), 215.
Town in north central San Luis Obispo County.

Pepperwood (B 6), 244.
Road station on the lower Eel River.

Pescadero (E 16), 100, 101.
Coast village in San Mateo County.

Petaluma (E 13), 186.
Town in southern Sonoma County.

Petrolia (A 6), 189, 262, 263.
Village on the lower Mattole River, Humboldt County.

Pine Grove (J 12), 224.
Road station east of Sutter Creek, Amador County, altitude 2,500 feet.

Piñon Flats (U 27), 172.
North of Santa Rosa Mountain, Riverside County.

Placer County (I 11), 140, 184, 272.

Plumas County (J 7), 183, 190.

Point Arena (B 10), 96.
Headland on the southern Mendocino Coast.

Point Lobos (F 18), 155.
Headland south of mouth of Carmel River; on some maps called Point Carmelo.

Point Pinos (F 18), 96.

Point Reyes (D 13), 42, 262.
Headland on the Marin Coast.

Peninsula (D 13), 96, 98, 99, 243, 244, 263.
Formed by Tomales and Drake's bays.

Pope Valley (F 12), 131, 159.
Napa County, east of Napa Range.

Porter Creek (E 12), 279.
Tributary of Mark West Creek, Sonoma County.

Posts (G 19), 274.
Terminal road station, Sur coast.

Potter Valley (D 10), 206.
Eastern Mendocino County.

Preston Peak (C 2), 112.
The dominant peak of the Klamath Range.

Priest Valley (J 19), 176, 179, 206, 280.
Eastern Monterey County.

Providence Mountains (W 23), 280.
Desert range in San Bernardino County near Nevada boundary.

Puente Hills (Q 27), 193.
Los Angeles County near Whittier.

Putah Creek (F 11), 10, 178.
West tributary of the lower Sacramento River, heading about Cobb Mountain, Lake County.

Pyramid Lake, 94.
Western Nevada.

Quartz Creek (B 2), 152.
Eastern Del Norte County, tributary of south fork of Smith River.

Quinns Pass (O 19), 76.
Pass in the Sierra Nevada from the Big Arroyo country to the Little Kern River.

Randolph Flat (I 10), 177.
Old-time mining settlement in Nevada County between Smartsville and Nevada City.

Red Bluff (F 7), 42, 177, 178, 214,
Town in Tehama County.

Red Mountain (D 10), 49, 158, 159, 231.
Southeastern Mendocino County in Mayacamas Range. The Red Mountain of Dr. Albert Kellogg's writings is near the northern boundary of Mendocino County, just west of the Blue Rock Ridge. There is also a Red Mountain in the Siskiyous (D 1), p. 112.

Redding (F 5), 214.
Town in Shasta County, upper Sacramento Valley.

"Redwood Belt."
Descriptive term applied to the narrow strip along the coast from the Santa Lucia Mountains north to the Oregon line.

Redwood Creek (B 4), 166, 212, 266.
Stream paralleling and lying between Mad and Trinity rivers.

Peak (F 14), 54, 132.
Oakland Hills.

Riverside (S 27), 249.
City in western Riverside County.

County (V 27).

Ross Valley (E 14), 175.
Northeast base of Mt. Tamalpais.

Round Meadow (O 18), 145.
In Giant Forest, Kaweah Basin.

Round Valley (D 8), 186, 206, 214, 252, 273.
Northeastern Mendocino County.
Rubicon River (K 10), 123.
Tributary of North Fork American River.
Russian River (D 11), 249.
Emptying into the Pacific Ocean on the Sonoma coast, heading in east central Mendocino County.
Valley (D 12), 210, 226.
About Healdsburg, Sonoma County.
Sacramento (H 12), 42, 178.
City on the Sacramento River at the junction of the American River.
County (H 12). *See also* Fair Oaks and Grand Island.
River (G 10), 151, 176, 188, 196, 248, 269, 278.
Lower (G 13), 269.
The lowlands and delta islands from Sacramento to Suisun Bay.
Cañon (F 4), 152, 231, 265.
From Kennett to Shasta Springs.
Valley (G 9), 9, 10, 29, 186, 197, 204, 214, 230, 248, 265, 278.
Northern arm of the Great Valley of California.
St. Helena (E 12), 31, 55, 88, 175, 177.
Town in Napa County.
Salinas River (H 19), 130, 180.
Emptying into Monterey Bay and heading in northern San Luis Obispo County.
Salmon Mountains (D 4), 119, 122.
Lying at the headwaters of the south fork of the Salmon River, on the boundary between Siskiyou and Trinity counties.
River (D 3), 188, 212.
Tributary of the Klamath River, southwestern Siskiyou County.
North Fork, 112.
South Fork, 88, 201, 262.
Trail (C 3), 240.
From the fork of Salmon River to Salmon Summit.
Summit (C 3), 240, 267.
Mountain south of Salmon Forks.
Salt Creek Fork of the Cottonwood, *see* Cottonwood Creek.
Salton (W 28), 20.
Railway station in northwestern Colorado Desert.
Samuels Springs (F 12), 159.
Resort in Napa County.
San Antonio Creek (J 13), 167.
Tributary of South Fork Calaveras River.
Mission, *see* Mission San Antonio.
River (H 20), 188, 205, 215.
Southern Monterey County, tributary of the Salinas River.
San Benito County (I 18), 129.
Peak (J 19), 88, 148, 280.
San Carlos Range.
River (I 18), 38, 183, 224.
Tributary of the Pajaro River, heading in the San Carlos Range.
San Bernardino County, *see* San Bernardino Mountains and Valley.
San Bernardino Mountains (T 26), 20, 75, 81, 82, 94, 103, 117, 120, 148, 164, 181, 189, 192, 193, 233, 243, 248, 251, 265, 269, 271, 272, 278.
The easterly continuation of the Sierra Madre, often written San Bernardino Range.
Valley (S 26), 162, 187, 248.
Lying at the southerly base of the San Bernardino Mountains.
San Buenaventura (M 26), 189.
Town in southern Ventura County. Written Ventura on most current maps.
San Carlos Range (J 19), 79, 86, 87, 88, 148, 218, 219.
Inner South Coast Range from Panoche Pass to Warthan Creek.
San Clemente Island (P 30), 220, 255.
One of the Santa Barbara Islands.
San Diego (S 31), 14, 219, 257.
City on the Pacific Ocean, San Diego County.
Coast (S 30, 31), 91.
County (U 30), 86, 92, 158, 248, 265, 278.
San Emigdio Cañon (N 24), 218.
Southern Kern County.
Mountains (M 24), 117.
South Kern County. San Emigdio Mountain is 7,415 feet high.
San Felipe, 260, 261.
Old road station in northeastern San Diego County.
Cañon (V 30), 117.
Eastern San Diego County.
San Fernando (P 26), 192.
Village on the plain (p. 204) of the San Fernando Valley (p. 215), Los Angeles County.
San Francisco (E 14), 42, 253.
City and County of San Francisco.
San Gabriel Mountains (Q 26), 20, 94, 272.
The first, or lower, range of the Sierra Madre. Often preferred to the name Sierra Madre, which see.
Wash (Q 26), 162.
The flood bed of the San Gabriel River on the plain at base of the Sierra Madre.
San Ignacio Valley (F 14), 226.
Central Contra Costa County.
San Jacinto Lake (S 27), 257.
In San Jacinto Valley, west of Mt. San Jacinto.
Mountain (T 27), 37, 94, 117, 162, 172, 180, 189, 222, 231, 241, 243, 271, 279, 280.
Western Riverside County, altitude 10,805 feet.
Range (T 27), 20, 75, 81, 82, 120, 148, 178, 225, 227, 233, 248, 278.
Valley (S 27), 179.
From Mount San Jacinto south to Santa Rosa Mountain.
San Joaquin County (H 13).
Lower San Joaquin River.
San Joaquin River (J 17), 114, 248, 269.
One of the two great river systems of central California.

South Fork (N 16), 23, 45, 183, 189.
Lies, and North Fork also, in the Sierra Nevada.

San Joaquin Valley (I 16), 9, 10, 23, 29, 186, 197, 204, 214, 230, 265, 278.
Southern arm of the Great Valley of California.

San Leandro Cañon (F 14), 55.
The cañon of upper San Leandro Creek, east of the Oakland Hills.

Creek (F 14), 248.
Draining southwestern Contra Costa County, and emptying into San Francisco Bay.

San Lorenzo River (F 16), 129.

San Luis Obispo (J 22), 16, 96, 248, 262.
Town in San Luis Obispo County.

San Mateo County (E 15), 129, 182.

San Nicolas Island (M 29), 14.
One of the Santa Barbara Islands.

San Pablo Creek (F 14), 269.
Stream in western Contra Costa County, the West Branch draining the east slope of the southern Berkeley Hills.

San Rafael Range (L 24), 94.
Mountains in central Santa Barbara County. Also written Sierra San Rafael.

San Ramon Valley (F 14), 206.
Southern Contra Costa County.

San Simeon Bay (H 21), 100, 101.
Coast of northern San Luis Obispo County.

San Ysidro Mountain (V 29), 173.
Northeastern San Diego County, altitude 5,873 feet. The "San Ysidro Mountains" are on the southern boundary of the county.

Santa Ana Mountains (R 27), 20, 192, 193, 226.
Range between Orange and Riverside counties. Also written (as originally) Sierra Santa Ana.

River (R 26), 178, 249.
Emptying into the Pacific Ocean and heading in the San Bernardino Range.

Santa Barbara (L 25), 181, 182, 192, 204, 218, 236, 248, 269.
Town on the Santa Barbara coast.

County (K 24), 117. *See also* Santa Inez Range.

Islands (K 26), 14, 189.
Collective name for the islands off the Southern California coast and including Anacapa, Santa Cruz, Santa Rosa, San Miguel, Santa Barbara, Santa Catalina, San Nicolas, and San Clemente. The first four are sometimes spoken of as the "Channel Islands."

Santa Catalina Island (P 28), 49, 189, 220, 251, 253, 255. *See also* Santa Barbara Islands.

Santa Clara County (G 16), 189. *See also* Mount Hamilton.

River (N 25), 189.
Emptying into the Pacific Ocean near San Buenaventura, heading near Soledad Pass on western boundary of Mohave Desert.

Valley (G 16), 129, 226, 248.
Between the Santa Cruz Mountains and Mount Hamilton Range. The valley of the Santa Clara River in Southern California is also known as the Santa Clara Valley.

Santa Cruz (F 17), 132, 138.
Town on Monterey Bay.

County (F 17), 136, 165.

Island (L 26), 49, 101, 189, 220, 255. *See also* Santa Barbara Islands.

Mountains (F 16), 13, 55, 79, 87, 103, 115, 129, 130, 158, 166, 181, 188, 231, 236, 248, 262, 265, 272, 276.
The range on the coast from the Pajaro River north through San Mateo County to the San Bruno Hills.

Santa Inez Mission, *see* Mission Santa Inez.

Santa Inez Range (K 25), 117, 199, 226, 236, 265, 272.
Mountains on the south coast of Santa Barbara. Also written Sierra Santa Inez.

River (K 24), 192, 236.
Emptying into the Pacific Ocean and running easterly along the north base of the Santa Inez Range.

Santa Lucia Peak (H 20), 85.

Santa Lucia Mountains (H 20), 13, 14, 17, 71, 79, 87, 103, 115, 124, 130, 131, 148, 158, 182, 188, 219, 236, 252, 262, 265, 272, 274.
The Santa Lucias, or Santa Lucia Range of mountains, overhang the Pacific Ocean on the Monterey coast and extend from Monterey south into San Luis Obispo County oposite San Luis Obispo town. The range is remarkable for the number of local species found in it: *Cupressus macrocarpa*, *Cupressus Goveniana*, *Pinus radiata*, and *Pinus muricata* occur at the northerly end of this range, *Abies venusta* in the high montane region, and *Pinus radiata* and *Pinus muricata* at low elevations in the southerly part of the range. *Pinus radiata*, according to I. J. Condit, grows in the hills back of the village of Cambria, and *Pinus muricata* occurs immediately on the coast west of San Luis Obispo town, being scattered for some distance along Coon Creek and with at least one station at head of Diablo Cañon. These are the first definitely defined and recorded localities for these species in San Luis Obispo County, so far as the writer is aware.

Santa Maria River (J 23) 192.
On the boundary between Santa Barbara and San Luis Obispo counties, its chief tributaries, the Cuyama and Sisquoc rivers.

Santa Monica (O 26), 204.
Town in Los Angeles County.

Mountains (O 26), 192, 272.
Range on the coast west of Los Angeles. Also written Sierra Santa Monica.

Santa Rosa Island (K 27), 14, 91, 101, 189, 220, 255, *See also* Santa Barbara Islands.

Mountain (U 28), 20, 93.
San Jacinto Range, Riverside County. Santa Rosa Mountain consists of three or four peaks, indicated as follows on U. S. Geological Survey maps: Santa Rosa Mountain proper, altitude 8,046 feet; El Toro Peak, altitude 8,705 feet; and a third southerly (unnamed) peak, altitude 7,072 feet. At the time of the author's visit (in 1901) there was evidently local confusion as to the nomenclature of the peaks. The collecting and photographing of *Pinus flexilis* was, however, presumably done on El Toro.

Valley (E 12), 16, 178, 210, 214, 215, 233.
Between the Mount Hood Range and the Sonoma Coast Range.

Santiago Cañon (R 27), 193.
Western slope of the Santa Ana Mountains.

Saugus (P 25), 162, 204.
Village in western Los Angeles County on the upper Santa Clara River.

Sawtooth Range (O 18), 76.
Lying between East Fork Kaweah River and Kern Cañon.

Scott Bar (D 2), 45.
Village in western Siskiyou County on Scotts River near the Klamath River.

Mountains (E 3), 17, 73, 76, 81, 211, 251.
Range on the headwaters of Scotts River, southern Siskiyou County.

Valley, west central Siskiyou County (E 2), 45, 76, 189, 206.

Valley, Lake County (D 10), 162, 206.

Sebastopol (D 12), 49.
Town in western Sonoma County.

Seiad Creek (D 1), 160.
Small north tributary of the Klamath in western Siskiyou County.

Sequoia National Park (O 18, 19).
Chiefly on basin of Kaweah River, 24 miles long (north to south) and 12 miles wide except in the middle, where it is six miles wide.

Sespe River (N 25), 94.
Tributary of the Santa Clara River in Ventura County.

Seward Ranch Ridge (C 7), 166.
Northerly continuation of the Blue Rock Ridge.

Shackelford Valley (E 2), 189.
West central Siskiyou County.

Shasta (F 5), 159.
Mining town in western Shasta County.

County (G 5), 159, 204. *See also* Redding.

Mount, *see* Mount Shasta.

River (F 2), 188.
Tributary of the Klamath River, heading on northerly side of Mount Shasta.

Springs (F 4), 252.
Village in the Sacramento River Cañon.

Valley (F 2), 81, 251.
Northerly base of Mount Shasta.

Shelley Creek (C 1), 152, 166, 237.
Tributary of Middle Fork Smith River.

Sherwood (C 9), 240.
Stage station in central Mendocino County.

Valley (C 9), 78, 166, 167, 274.
Central Mendocino County.

Sierra County (J 8), 183.

Sierra Liebre (O 24), 87, 214.
Abbreviated from Sierra de la Liebre, range extending southeasterly from the west end of Tehachapi Mountains.

Sierra Madre (Q 25), 75, 94, 117, 120, 148, 189, 192, 193, 231, 233, 248, 265, 278.
The range from Cajon Pass westerly to the Soledad Cañon. *See also* San Gabriel Mountains.

Sierra Nevada (K 10), 9, 10, 18, 22, 29, 69, 70, 73, 76, 78, 81, 82, 87, 88, 94, 95, 108, 114, 115, 119, 122, 140, 148, 159, 179, 180, 181, 182, 183, 185, 188, 189, 197, 200, 201, 218, 222, 224, 231, 232, 233, 236, 241, 242, 243, 248, 251, 253, 63, 265, 272, 278.
The great mountain chain on the eastern boundary of the state and extending from Tehachapi Pass north to Pitt River. In the botanical and general literature often called simply "Sierras," or "High Sierra."

Sierra Nevada foothills, 88, 186, 204, 215, 229.
The first or lower elevations of the Sierra Nevada on the west, rising from the plains of the Great Valley.

Sierra Santa Ana, *see* Santa Ana Mountains.

Sierra Santa Monica, *see* Santa Monica Mountains.

Sims (F 5), 188.
Village on the upper Sacramento River in Shasta County.

Siskiyou County (F 2), 45, 76, 103, 104, 148, 160, 184, 189, 211, 239, 253, 272.
Often referred to simply as Siskiyou.

Mountains (D 1), 17, 39, 69, 71, 81, 82, 108, 112, 119, 200, 237, 268.
On the boundary between California and Oregon, northwestern Siskiyou County. Often referred to as the Siskiyous.

Sisson (F 3), 252.
Village at west base of Mount Shasta.

Smith River (B 2), 129, 138.
Emptying into Pacific Ocean and draining west slope of Klamath Range.

Snow Mountain (E 9), 39, 71, 120, 122.
Northern Lake County.

Soda Springs, Tuolumne (M 14), 184.
In Tuolumne Meadows, altitude 8,594 feet.

Solano County (G 13), 177, 208, 215.

Soledad River (S 30), 91.
Stream, western San Diego County, emptying into the Pacific Ocean.

Sonoma (E 13), 234, 254.
Southern Sonoma County.

County (D 12), 71, 96, 121, 132, 168, 226, 246, 265, 273, 279.

Creek (E 13), 182.
Stream, southern Sonoma County, emptying into San Pablo Bay.

Sonora (J 14), 260.
Town in Tuolumne County.

Southern California, *see* California, Southern.

Stanislaus County (I 15).
Lying mainly in the San Joaquin Valley. *See also* Modesto.

River (J 14), 232.
Tributary of the San Joaquin River heading in the Sierra Nevada.

Stevenson Creek (M 16), 114.
South tributary of main San Joaquin River, at about 4,500 feet.

Stewarts Point (C 11), 96, 98.
Southern Sonoma coast.

Stony Creek (F 8), 162.
Tributary of the Sacramento River, mainly in Glenn County, but heading about Snow Mountain and Mount St. John.

Suisun Valley (F 13), 206, 230.
Western Solano County.

Summerville (D 4), 211.
Settlement in southwestern Siskiyou County on the South Fork Salmon River.

Summit (J 10), 184.
Station in Placer County.

Sur Coast (F 19), 23, 55.
The Monterey coast from Point Lobos to Point Sur.

Sur River, Big (G 19), 85, 130, 139, 188, 189, 249.
Stream in the northern Santa Lucia Mountains emptying into the Pacific Ocean. The Little Sur River (p. 249) is just north of the Big Sur.

Sutter County (G 10), 178. *Also see* Marysville Buttes.

Sylvandale (C 9), 166.
Road station, central Mendocino County.

Tahoe, Lake (K 10), 161.
On eastern border of California, and partly in Nevada; altitude 6,225 feet.

Tehachapi Pass (P 23), 95.
Pass from the upper San Joaquin Valley to the Mohave Desert at east end of Tehachapi Range.

Range (O 23), 87, 94, 117, 231.
Mountains separating the upper San Joaquin Valley from the Mohave Desert.

Tehama County (F 7), 38, 178, 186, 216, 265.

Tehipite Valley (O 17), 178.
Cañon-valley on Middle Fork Kings River.

Thompson Peak (D 4), 108, 112.
Northern Trinity County.

Three Creeks (C 4), 166.
Streams near Hupa Valley, tributary to Trinity River.

Three Rivers (N 19).
Village near junctions of the Kaweah River forks.

Tomales Bay (D 13), 199, 269.
On the Marin coast.

Point (D 13), 96, 98.
Western headland at entrance of Tomales Bay.

Tres Piños (H 17), 162.
Village in northern San Benito County.

Trinity County (D 5), 31, 76, 103, 148, 152, 160, 186, 268, 274.

Mountains (E 5), 69, 71, 112, 115, 122, 211.
Here used in the sense of the mountains of Trinity County; more specifically it means the range between the upper Trinity River in Trinity County and the Sacramento River Cañon, extending south to Trinity Mountain and north to Eddy Mountain. Usage should be restricted as indicated.

River (C 5), 17, 204.
Tributary of the Klamath River, heading in the Trinity and Scott mountains.

South Fork (C 5), 262.

Summit (C 4), 119, 188, 200, 211, 219, 252, 267, 274.
Mountain in northeastern Humboldt County between Hupa Valley and Salmon River Forks.

Truckee River (K 10), 40.
Outlet of Lake Tahoe and emptying into Pyramid Lake, Nevada.

Tulare County (N 19), 140, 165.

River, 140.
Misprint for Tule River; also misprinted on some maps. *See* Tule River.

Tule River (N 20), 140, 141, 142.
Rising in the southern Sierra Nevada and flowing west into Tulare Lake.

Middle Fork (O 20), 23, 76.

Tuolumne County (K 14). *See also* Sonora and Tuolumne River.

River (J 15)
Tributary of the San Joaquin River, heading at Mounts Lyell and Dana in the Sierra Nevada.

Twin Sisters Peak (F 13), 47, 231, 244, 265.
Southerly part of the Napa Range.

Ukiah (D 10), 47, 167, 178, 186, 199, 211, 222, 249, 269.
Town in southern Mendocino County.

Valley (D 10), 16, 78, 210, 214, 227, 230.
Southern Mendocino County.

Ulatis Creek (G 13), 10.
Solano County, small tributary of the Sacramento River, heading in the Vaca Mountains.

Umpqua River, 72.
Southern Oregon.

Uncle Sam Mountain (E 11), 231.
South of Clear Lake, Lake County; the name, Mount Konokti, is now generally preferred.

Usal (B 8), 283.
Abandoned mill village on the northern Mendocino coast.

Vaca Mountains (F 12), 17, 78, 132, 167, 177, 178, 188, 218, 231, 244, 262, 265, 273, 275.
Ridge bounding northwestern Solano County. Has only one conifer, *Pinus sabiniana*, although *Torreya californica*, thought to have become extinct from fire ravage, is still found in one locality.

Vandeventer's Ranch (T 27), 225, 227.
Camp between Mount San Jacinto and Santa Rosa Mountain at head of Palm Cañon; altitude 4,549 feet.

Van Duzen River (B 5), 134.
Paralleling Eel and Mad rivers, and a tributary of the former; also spelled Van Doosen.

Ventura. *See* San Buenaventura.

Ventura County (N 24), 87, 120, 194. *See also* Mount Pinos.

Volcano Creek (P 19), 181.
East tributary of Kern River, heading Whitney Meadows. The U. S. Geographic Board accepts the name, Golden Trout Creek.

Walker Pass (Q 21), 94, 170.
Pass over the Sierra Nevada just south of Owens Peak and opposite Kernville.

River (M 13), 94.
Heading on the east slope of the Sierra Nevada in Alpine and Mono counties and emptying into Walker Lake, Nevada.

Valley (C 9), 211, 213, 274.
Mountain valley between Ukiah and Willits.

Walnut Creek (F 14), 193.
Stream in Contra Costa County heading in the Las Trampas Ridge and emptying into Suisun Bay.

Warner Hot Springs (U 29), 278.
North central San Diego County.

Mountains (K 2), 184, 201.
A range in northeastern Modoc County.

Warthan Creek (J 19), 176, 262.
Southerly end of the San Carlos Range, tributary of Los Gatos Creek.

Weber Creek (J 11), 123, 167.
Tributary of South Fork American River, Eldorado County.

West Point (J 13), 49.
Village in Calaveras County, near forks of Mokelumne River, altitude 2,800 feet.

West Vidette (O 18), 76, 108.
Peak on the upper waters of Bubbs Creek, altitude 12,229 feet.

Whiskeytown (F 5), 159.
Village in western Shasta County.

White Mountains (P 15), 93, 163.
North and south range, Mono County, extending south into Inyo County.

"White Plains," *see* Mendocino County.

White River (N 21), 87.
Heading in the Greenhorn Mountains (southern Sierra Nevada) and emptying into Tulare Lake.

Whitewater Cañon (U 26), 173.
Cañon of Whitewater River, southeasterly slope of San Bernardino Mountains, near Marongo Pass.

Whitney Creek (P 18), 268.
East tributary of Kern River, heading on Mount Whitney.

Mount, *see* Mount Whitney.

Plateau (P 18), 76.
Between Kern Cañon and Mounts Tyndall, Whitney, and Langley, altitude 10,000 to 11,000 feet.

Whittier (Q 27), 193.
Town near Los Angeles.

Wildcat Creek (F 14), 248.
Tributary of San Pablo Creek.

Wilder Ridge (B 7), 38, 273.
Southwestern Humboldt County.

Willits (D 9), 31, 206, 211, 227, 240, 274.
Town in central Mendocino County.

Wooden Valley (F 12), 192, 194.
North of Suisun Valley, Solano County.

Yollo Bolly Range (D 7), 17, 39, 71, 76, 81, 115, 120, 122, 148, 188, 211, 233.
Inner North Coast Range north of Clear Lake as far as the Bully Choop Mountains.

Yollo Bolly, South (D 7), 164.

Yolo County (G 12).
West side of the Sacramento Valley. *See also* Cache Creek.

Yosemite National Park, central Sierra Nevada, about 36 miles from north to south and 42 miles from east to west, including Yosemite and Hetch-Hetchy valleys, Grand Cañon of the Tuolumne and Mounts Dana, Gibbs, and Lyell.

Yosemite Valley (L 15), 167, 178, 188, 189, 222, 243, 252, 265.
Cañon-valley in the Sierra Nevada in Mariposa County, altitude 4,000 feet.

Yuba County (H 10).
In the Sacramento Valley.

Yuba River (H 10), 168.
Tributary of the Feather River, heading in the Sierra Nevada.

Yuma (Z 30), 270.
Town on the Arizona side of the Colorado River, opposite the southeastern corner of California.

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